

**FORT LEWIS
CROSS CONNECTION CONTROL PROGRAM**

**SECTION 6: CROSS CONNECTION CONTROL
MANUAL-ACCEPTED PROCEDURE AND PRACTICE.
Pacific Northwest Section, A.W.W.A. May 1990**

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Cross Connection Control Manual

Accepted Procedure and Practice

Cross Connection Control Committee
Pacific Northwest Section — AWWA



Cross Connection Control Manual

Accepted Procedure and Practice

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Application Of Manual

This manual is intended to augment state and local plumbing codes, and has been prepared as a minimum standard for cross connection control. The primary thrust of this manual is to outline recommended procedures for a cross connection program that will protect the public and the consumer's potable water system from contamination or pollution.

Foreword

Fifth Edition

Water purveyors are hard pressed to keep up with cross connection control, due to advances in technology, as new and different water using equipment or systems are developed. As a result of these developments, regulations must change. Therefore, manuals such as this one must change to keep up with the advancing technology.

We in the Pacific Northwest have long considered ourselves to be leaders in the field of cross connection control. We continue to be leaders by being the first manual to include a chapter on safety for inspectors and testers. We are also among the first to recognize the potential danger of backflow from fire protection systems which may contain chemical additives, high concentrations of metals, or non-potable piping. Therefore, we require approved backflow protection on all fire services.

I had the honor of working under Mr. John Roller, who was chairman of the PNWS/AWWA Cross Connection Control Committee when the First and Second Editions of this manual were published. I have assisted in the development of each edition of this manual, including the first. It is an honor for me to have my name listed along with that of John Roller, the other Past Committee Chairmen, and all the past and present Committee members who have put so many hours into making this manual the best available.

In the foreword of the First Edition, Mr. Roller wrote: "As was once remarked by an ancient scholar 'One man cannot see everything'. It is with this in mind that the time and effort of the Committee members, past and present, is gratefully acknowledged. Further, it is the Committee's wish this manual be reviewed, revised and updated as required".

I wish to reaffirm this statement.

R. L. Pettie, Chairman
Cross Connection
Control Committee

Introduction

Technology has made it possible to deliver safe (potable) drinking water of high quality to the distribution systems of public water supplies. However, to assure safe water at the consumer's tap, it is essential that physical cross connections and backflow possibilities are eliminated from the distribution system and the plumbing systems in buildings. The backflow menace in buildings is especially significant. When this condition occurs, the potable water may become a transmitter of disease, toxic materials, or other hazardous substances. Health and water supply officials recognize that measures of protecting the source of supply, and providing treatment, are not sufficient in themselves to guarantee safe water at the consumer's tap.

Plumbing fixtures such as the consumer's tap and basin are actually the end of the water supply system, and the beginning of the sewerage system. The line of separation is sometimes finely drawn, but it determines whether the water supply system is safe for human use. Backflow from secondary or unsafe water supplies into the public supply is recognized as a potential hazard wherever such supplies are interconnected. Such an interconnection is known as a cross connection.

There are numerous and well-documented cases where cross connections have been responsible for contaminating drinking water and helped to spread disease. Many of these cases have been documented in A Summary of Backflow Incidents published by the Pacific Northwest Section American Water Works Association Cross Connection Control Committee. The problem of cross connection control is a continual one because piping systems are constantly being installed, altered, or extended. All potable water purveyors should have cross connection control surveillance programs to maximize the protection of potable water systems. Furthermore, in various court decisions, it has been held that the water purveyor is responsible for the delivery of safe water to the consumer.

This manual has been designed as a guide toward uniformity for water works personnel, plumbers, and others involved in the protection of the potable water system. It is particularly intended to promote and assist water purveyors within the Pacific Northwest Section of the American Water Works Association in implementing and setting of standards for cross connection control procedure and practice. The requirements and suggestions contained in this manual are based upon the understanding that a cross connection control program includes approved assemblies properly installed with adequate testing and maintenance by certified testers.

AWWA Policy Statement On Cross Connections

Cross Connections

Adopted by the Board of Directors on Jan. 26, 1970, and revised on June 24, 1979 and on Jan. 28, 1990.

AWWA recognizes that the water purveyor has a responsibility to provide its customers with water that is safe under all foreseeable circumstances. Thus, in the exercise of this responsibility, the water purveyor must take reasonable precaution to protect the community distribution system from the hazards originating on the premises of its customers that may degrade the water in the community distribution system.

Cross-connection control and plumbing inspections on premises of water customers are regulatory in nature and should be handled through rules, regulations, and recommendations of the state- or provincial-appointed authority or the plumbing-code enforcement agencies having jurisdiction. The water purveyor, however, should be aware of any situation requiring inspection and reinspection necessary to detect hazardous conditions resulting from cross connections. If in the opinion of the utility, effective measures consistent with the degree of hazard have not been taken by the regulatory agency, the water purveyor should take necessary measures to ensure that the community distribution system is protected from contamination. Such action would include the installation of a backflow prevention device, consistent with the degree of hazard, at the service connection or discontinuance of the service.

In addition, customer use of water from the community distribution system for cooling or other purposes within the customer's system and later returned to the community distribution system is not acceptable and is opposed by AWWA.

Section 1

Introduction To Cross Connection Control And Backflow Prevention

What Is A Cross Connection?

Within this manual a cross connection is defined as "Any actual or potential physical connection between a potable water line and any pipe, vessel, or machine containing a non-potable fluid, such that it is possible for the non-potable fluid to enter the potable water system by backflow."

To clarify and expand this definition, it is important to understand these key terms:

Actual cross connection: A cross connection that currently exists.

Potential cross connection: A cross connection that does not exist at the time of inspection, but may be made at any time. Examples of potential cross connections include bypass arrangements, jumper connections, unattached hose connections, intricate piping, etc.

Potable water: Water suitable for human ingestion, free from harmful or objectionable materials.

Non-potable fluid: All liquids and gases that are not potable water. The list of non-potable fluids is virtually infinite, but includes used water, fuel, liquid chemicals, gases, etc. Used water is any potable water which is no longer in the purveyor's distribution system. In most cases, this includes any water downstream (past) of the water meter and/or property line.

Backflow: The reverse from normal flow direction in a plumbing system or public water distribution system. It is caused by **backpressure** or **backsiphonage**. Backflow within a potable water piping system can cause contaminants to enter the drinking water through unprotected cross connections.

Hazards Associated With Backflow Contamination

In the past, cross connection incidents have resulted in many serious problems. It is helpful to separate the hazards created by cross connections into three categories: Biological Hazards, Chemical Hazards and Physical Hazards.

Biological Hazards

Backflow incidents have been documented by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research as early as 1903. These incidents show that drinking water contaminated from cross connections caused the deaths of numerous people. These deaths were primarily caused by serious waterborne infectious diseases such as typhoid fever and dysentery.

Note

A potential cross connection must be treated just like an actual cross connection.

Although waterborne illness is rarely associated with death in the United States today, the incidence of waterborne outbreaks continues to be of concern to our public health officials. Recent publications by the Oregon State Health Division show a continuous increase in the number of infectious disease cases normally associated with water and food transmission. Currently, these waterborne diseases are of the greatest concern:

Hepatitis A: Serious illness, fever, nausea, vomiting and jaundice.

Giardiasis: "Explosive", possibly long term diarrhea, excess gas and bloating, and weight loss.

Campylobacteriosis: Bloody diarrhea, nausea and vomiting.

Gastroenteritis: May include diarrhea, nausea, cramps, vomiting and fever.

Cross connections involving sewage or sewage contaminated water create a continued risk for transmission of these and other infectious diseases.

Chemical Hazards

Thousands of chemicals currently used in the United States have been registered by the U. S. Environmental Protection Agency for their toxicity to humans. These chemicals range from the raw materials used in manufacturing to the active ingredients of over-the-counter products, readily available to every American consumer. Chemicals that are intended for use in conjunction with water are the greatest threat to drinking water. A survey of backflow incidents quickly establishes the most notorious of problem chemicals (Table 1-1).

A review of recent backflow incidents from several sources indicates an increasing threat to drinking water integrity from chemical contaminants. In addition, it should be noted that many serious backflow incidents have occurred in recent years due to cross connections made on private single family dwellings.

Table 1-1: Problem Chemicals

Chemicals Typically Used With Water	Hazards
Boiler and heat exchanger compounds: chromates, nitrates, etc.	Highly toxic, in most cases
Cleaning agents: detergents, soaps, etc.	Moderate to high toxicity
Herbicides: 2,4-D, silvex, etc.	Possible carcinogens, mild to extreme toxicity
Insecticides: chlordane, dioxin, etc.	Possible carcinogens, mild to extreme toxicity
Water conditioning chemicals: phosphates, chlorine, etc.	Mild to extreme toxicity
Antifreeze: ethylene glycol, glycerine	Mild to extreme toxicity
Fertilizers/fungicides/etc.: ammonium nitrate, "penta," etc.	Mild to extreme toxicity

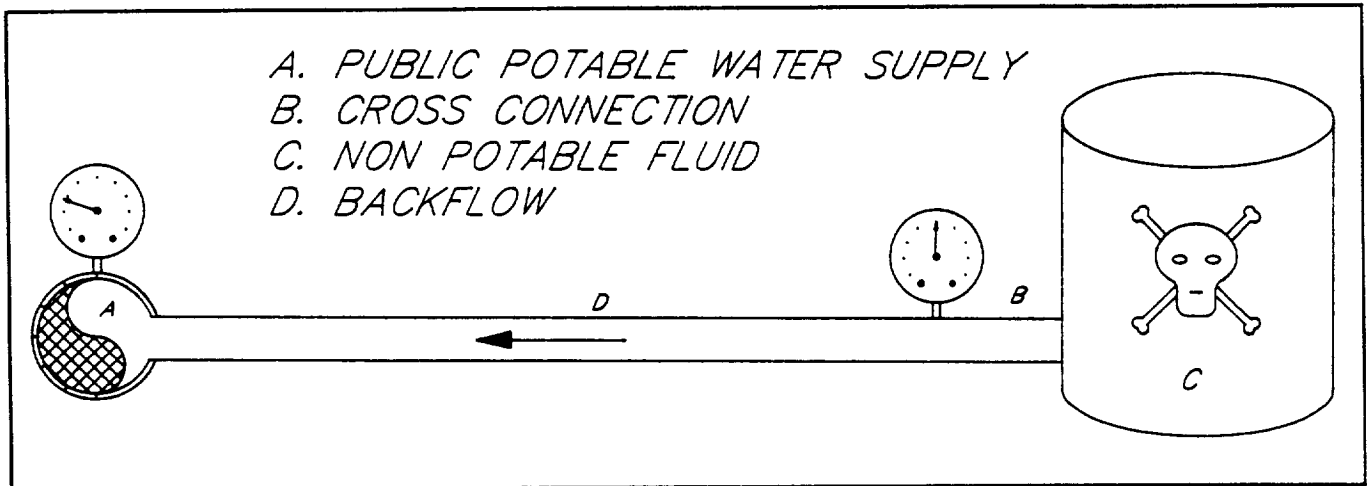


Figure 1-1: Contamination Of Water From Backflow.

Physical Hazards

When certain kinds of materials are introduced into water systems, the results can be quite dramatic. Fire, explosion, destruction of property, and physical injury have occurred when cross connections have resulted in backflow. For example, fuels such as propane may cause fires or explosions. Live steam causes burns.

Although physical injuries from cross connections are not very common, they are of great significance due to their tremendous potential for harming people and property.

Contamination Of Water From Backflow

To illustrate the fundamental causes of backflow contamination of water, consider Figure 1-1. Contaminants can enter a potable water line through a cross connection due to backflow caused by either backsiphonage or backpressure. Stated even more simply:

BACKFLOW CONTAMINATION	=	"LINK"	+	"FORCE"
		(Cross Connection)		(Backpressure or Backsiphonage)

This relationship helps to visualize some important concepts in cross connection control. The question could also be asked, "Which of the essential aspects of backflow contamination can be effectively and safely controlled?" Can backpressure and backsiphonage be eliminated from a potable water system? All properly installed plumbing systems are designed to minimize the possibilities of backpressure and backsiphonage. However, it should be clearly understood that the cause of these conditions are the result of unusual, accidental, or unique conditions which are not controllable. Since the hydraulic forces involved in backflow are not predictable, it becomes obvious that the elimination of backflow contamination must focus on the link; the cross connection itself.

Elimination Or Control Of Cross Connections

Any good cross connection control program must focus on eliminating or controlling actual or potential cross connections. However, it is impractical to eliminate all cross connections. Modern commercial, industrial, and agricultural facilities often require that potable water be used in such a way that creates an actual or potential cross connection. In this case, to effectively control cross connections, the link must be controlled.

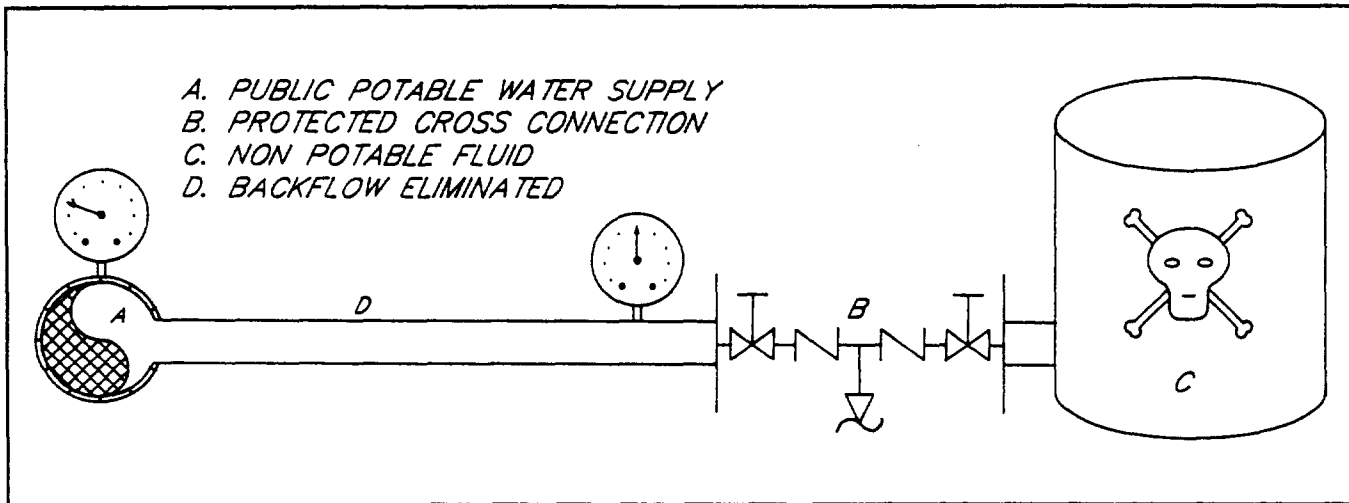


Figure 1-2: Controlled Cross Connection.

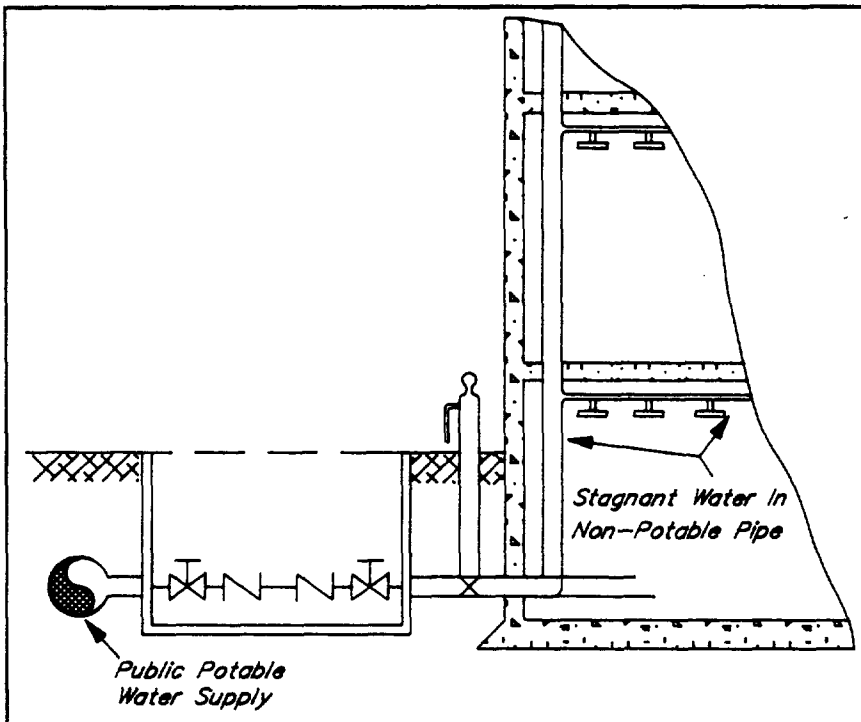
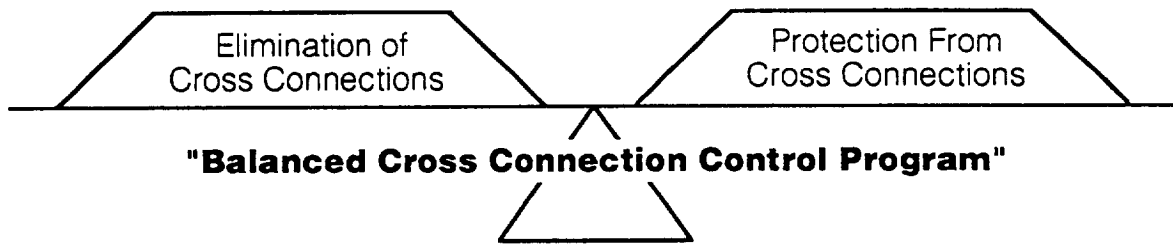


Figure 1-3: "Necessary" Cross Connection.

A closer look at Figure 1-2 reveals that one feature has been added. At a point between the potable water system and the source of contamination, an approved backflow prevention assembly has been installed. This assembly is designed to prevent backflow when properly installed. In this condition, the cross connection is considered to be protected.

Water service to the fire sprinkler system in a building (Figure 1-3) is an example of a "necessary" cross connection. The fire system is clearly non-potable and requires an approved backflow prevention assembly at the connection to the potable water system.

Selection of the proper type of backflow prevention assembly is based upon the degree of hazard and hydraulic conditions (see Section 3). The illustration on the next page shows how an effective Cross Connection Control program strikes a balance between the elimination of cross connections, and protection from the necessary ones.



Basic Hydraulics

Pressure

Pressure is defined as force per unit area. Typical units for expressing pressure are pounds per square inch (psi) or pounds per square foot (psf). Fluids, including water, are normally pressurized by one of three methods: pumping, compression, or elevation. It is very important to understand how a difference in elevation effects water pressure.

Fluids Exert Pressure Equally In All Directions

In the 1600's, Blaise Pascal, the father of hydrostatics, observed that the pressure exerted by water in a container open to the atmosphere was related only to the vertical height of the water (Figure 1-4).

Pascal concluded correctly that water pressure is not related in any way to these factors:

- the shape of the container
- the size of the container
- the total weight or amount of water (fluid)

Pascal determined that the pressure developed by a fluid in a vessel open to the atmosphere can be determined by the following relationship:

$$\text{Pressure} = \frac{\text{Weight}}{\text{density of fluid}} \times \text{Vertical height}^*$$

**From point of measurement to surface of fluid*

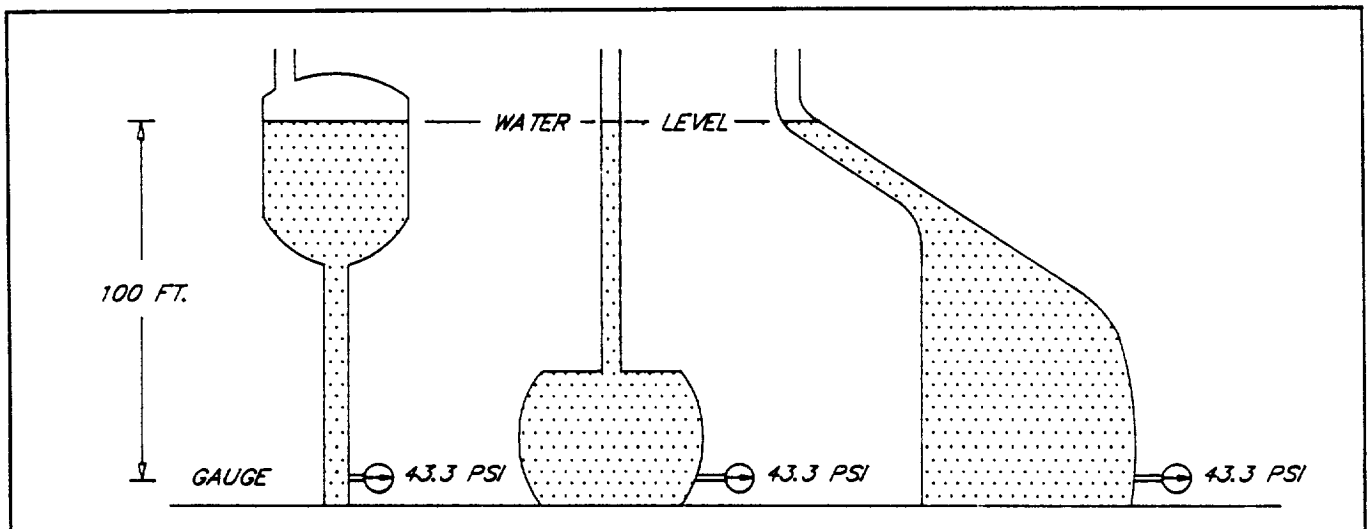


Figure 1-4: Equal Water Pressures.

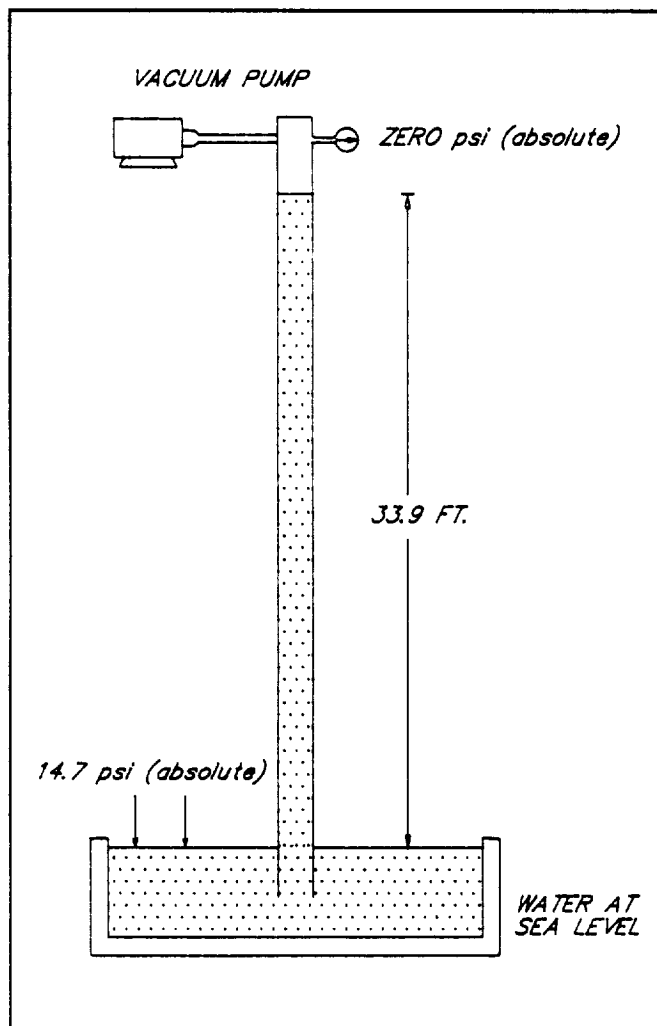


Figure 1-5: Water Column Produced By Vacuum.

Since the weight density of water is, for practical purposes, a constant (62.4 lb./cubic ft.), we can simplify the above expression to this familiar one:

$$\text{Pressure (psi)} = 0.433 \times \text{Elevation in feet}$$

or

$$\text{Elevation in feet} = \text{Pressure (psi)} \times 2.31$$

thus

$$2.31 \text{ feet} = 1 \text{ psi}$$

and

$$1 \text{ foot} = 0.433 \text{ psi}$$

Atmospheric Pressure And Vacuum

The earth's atmosphere has a thickness of approximately 7½ miles. The mixture of gases making up the atmosphere acts like a fluid under the influence of gravity, and exerts a pressure at sea level equal to 14.7 psi (absolute).

A partial vacuum plays a significant role in the hydraulics of backflow contamination for two primary reasons. First, since a vacuum represents a reduced pressure, fluids (water, etc.) always tend to flow toward a vacuum. In virtually all situations, when a vacuum condition occurs within a potable water piping system, the result is a reverse direction of flow, or backflow.

In addition, a vacuum has the unique ability to "lift" water above its free-standing liquid level. A casual observer might think that the vacuum is actually capable of "lifting" the water, but closer examination reveals that atmospheric pressure is actually "pushing" the water above the free water surface.

From Figure 1-5, it must be concluded that the height to which water can be drawn by a vacuum is directly related to the degree of vacuum. In addition, since the "push" that results from a vacuum comes from atmospheric pressure, the limit of "push" for a near perfect vacuum is 33.9 feet at sea level [(2.31 ft/1.0 psi) x 14.7 psi = 33.9 ft.].

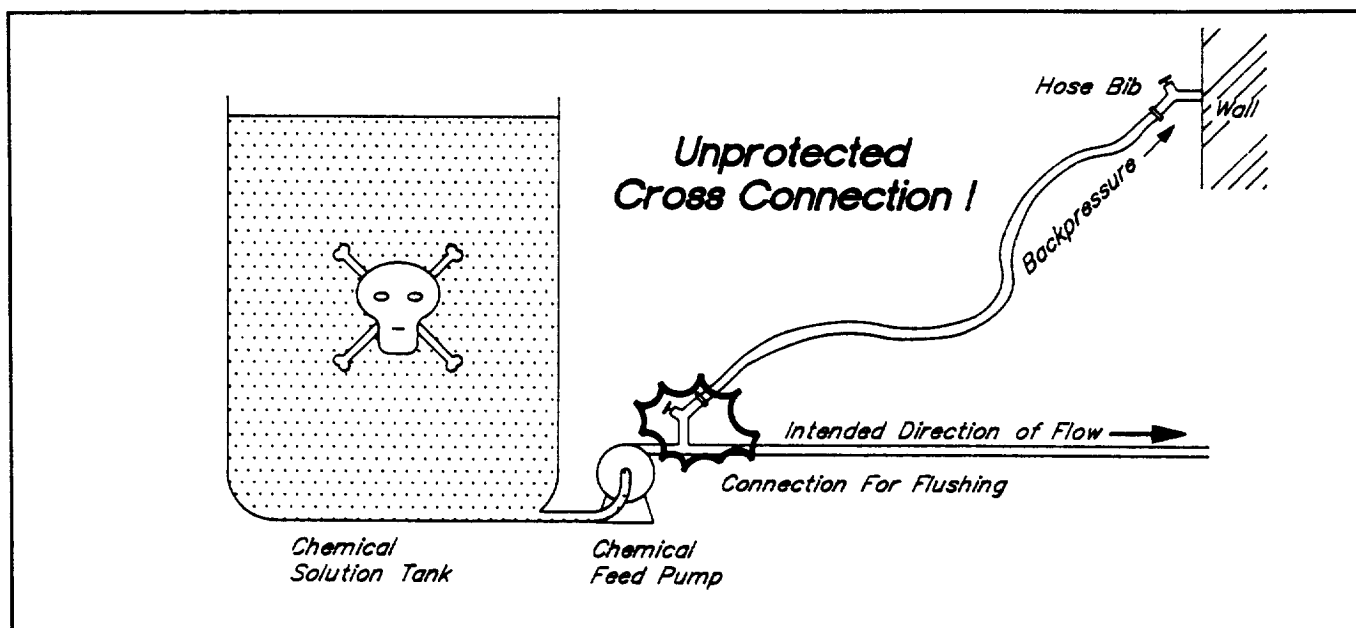


Figure 1-6: Backpressure From Chemical Feed Pump.

Hydraulics Of Backflow

It is extremely important to protect the domestic water system from contamination that can result from unprotected cross connections. Anyone attempting to implement a cross connection control program must be familiar with the kinds of facilities and equipment that pose a threat to the potable water system's integrity. In addition, the cross connection control inspector, or specialist, must be aware of the hydraulic conditions that can cause backflow.

An awareness of the potential for backpressure or backsiphonage conditions usually allows the program administrator to prescribe the most appropriate type of protection. When making water use inspections within facilities, it is of utmost importance to recognize the potential for adverse hydraulic conditions. Although the specific causes are numerous, the basic conditions are very simple.

There are two hydraulic conditions that can cause water within a potable water piping system to flow

in the reverse direction. Those conditions (forces) are backpressure and backsiphonage. It is important to have a basic understanding of these conditions (forces), but even more important to understand how they can routinely be produced within a typical potable water system

Backpressure Backflow

Backpressure backflow, also referred to as backpressure, is the reverse from normal flow direction within a piping system that is the result of the "downstream pressure" being higher than the supply pressure.

Although the specific situations that create a backpressure situation within a plumbing system are very numerous and diverse, the basic types of causes are relatively few. It is crucial to understand specific ways that the following conditions may occur within a typical potable water system.

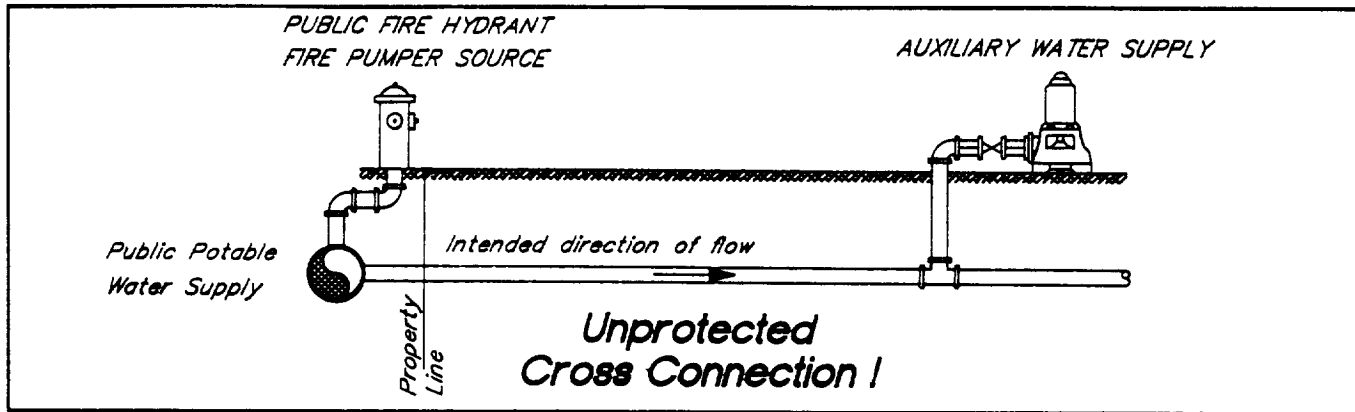


Figure 1-7: Backpressure From Auxiliary Water Supply.

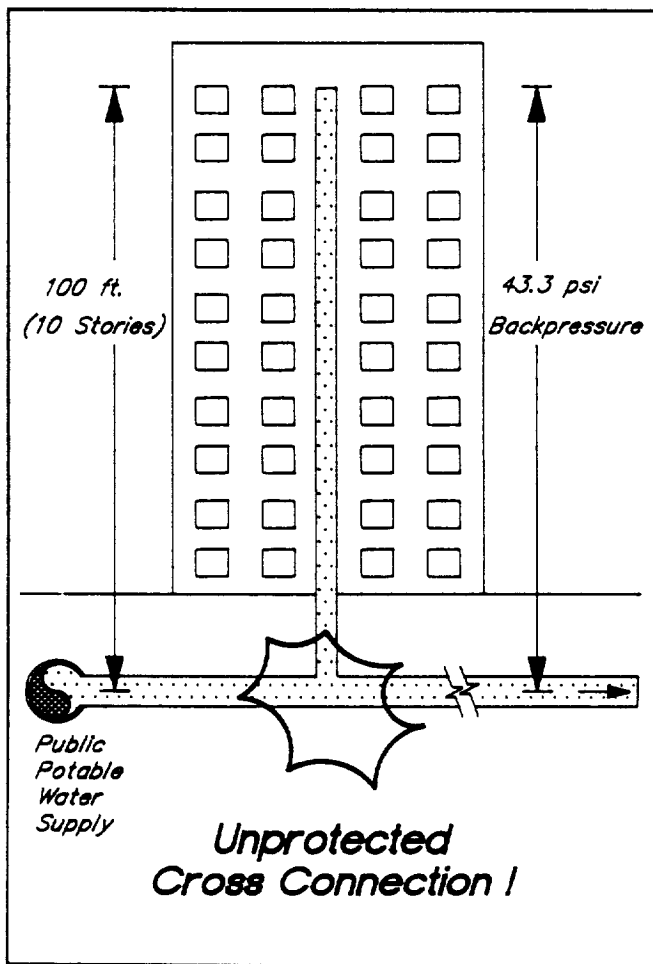


Figure 1-8: Backpressure From Elevated Piping.

Pressurized Systems

Anytime the potable water system is connected to a pumped or pressurized system that handles a fluid other than potable water, a cross connection is created and the potable water system may be subjected to backpressure. Examples of this type of cross connection are numerous.

Figure 1-6 shows the potential for backpressure as a result of connecting the hose to a flush line on the discharge side of a chemical feed pump. Figure 1-7 shows how backpressure may result by inter-connecting the potable water system to the discharge side of an auxiliary water system.

Elevated Piping

Anytime a potable water system delivers water to a point higher than its source, the possibility for backpressure is created. Backflow actually occurs every time the source pressure drops below the critical elevation head created by the height of the piping system. Figure 1-8 illustrates how water flows toward the source whenever the source pressure drops below 43.3 psi. This illustrates two important principles related to backpressure. First, the supply pressure does not need to drop to zero in order for backflow to occur. Secondly, greater differences in elevation increase the potential for backpressure. Water in a building (Figure 1-8) will backflow due to elevation backpressure when the water pressure in the main drops below 43.3 psi.

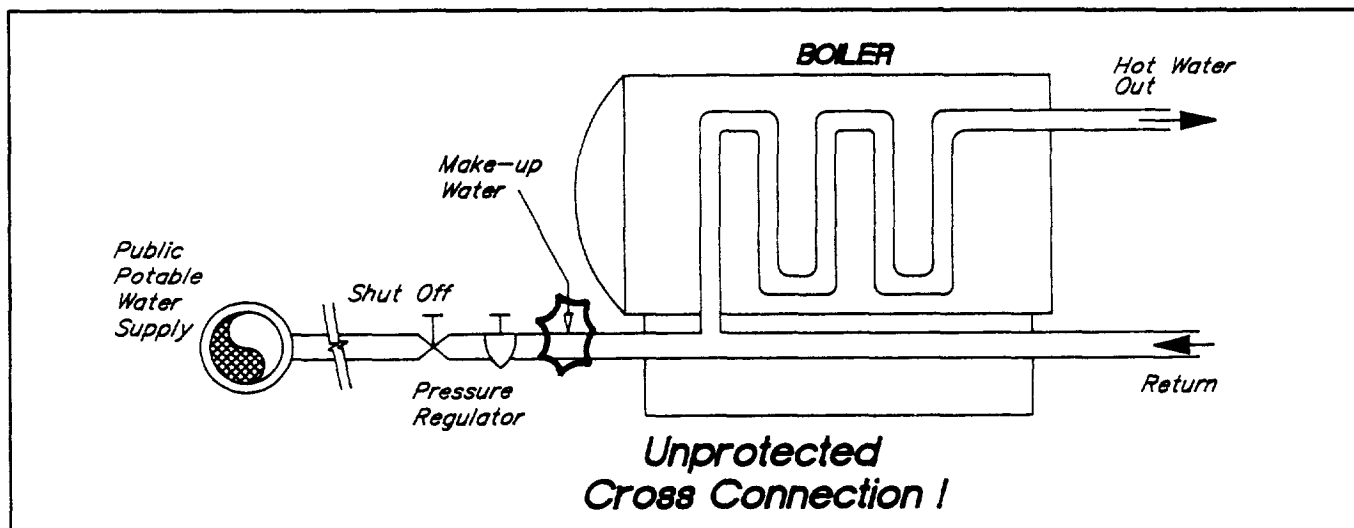


Figure 1-9: Backpressure From Boiler Thermal Expansion.

It is apparent that backpressure can occur quite often in a piping system that has source piping located a significant elevation below its outlets. The frequent pressure adjustments and brief backflow that occurs in these piping systems will not normally introduce contaminants unless a cross connection exists.

Thermal Expansion

If water is heated and not given room to expand, it develops pressure as the result of thermal expansion. One of the most important types of backpressure is illustrated in Figure 1-9. The boiler may develop backpressure due to thermal expansion which exceeds the pressure in the make-up water line, causing backflow to occur.

Pumps

Figure 1-10 shows how pumps on the customer's water system can increase the pressure to a point where it exceeds the city's main pressure causing backflow to occur.

It is common practice to flush vessel fire fighting systems by connecting to potable water supplies, or to use potable supplies for fire protection aboard

ships during shutdown or repair of pumps. As shown on the graph, under normal conditions the city's main has a pressure of 100 psi; approximately 75 psi where it enters the ship's system.

After completing flushing operations or pump repairs, a test is conducted to determine if the fire pumps aboard ship are operating properly. The graph shows that the fire system pressure is boosted to approximately 200 psi. If the valve at Point A is accidentally left open, the fire system pressure is transferred through the potable water supply to the city main at which point the pressure is just 150 psi. Now the customer's water system pressure is higher than that of the city main, forcing non-potable water into the potable water supply.

Potential Backpressure Conditions

- The existence within a facility of pumped or pressurized systems that handle other than potable water.
- Elevated piping (the source of water is significantly below the point of use).
- Thermal expansion resulting in increased pressure.

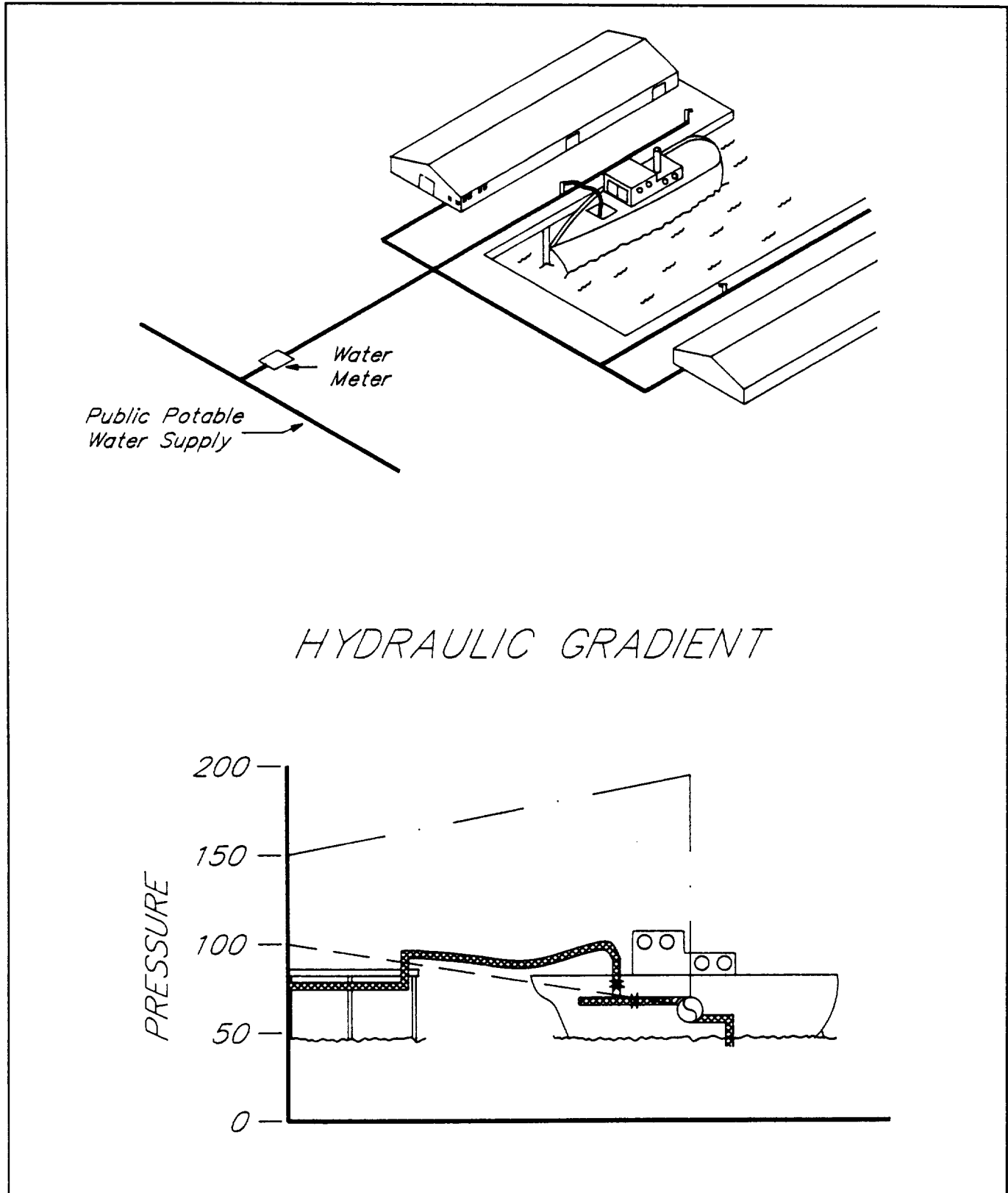


Figure 1-10: Backpressure From Pump Discharge.

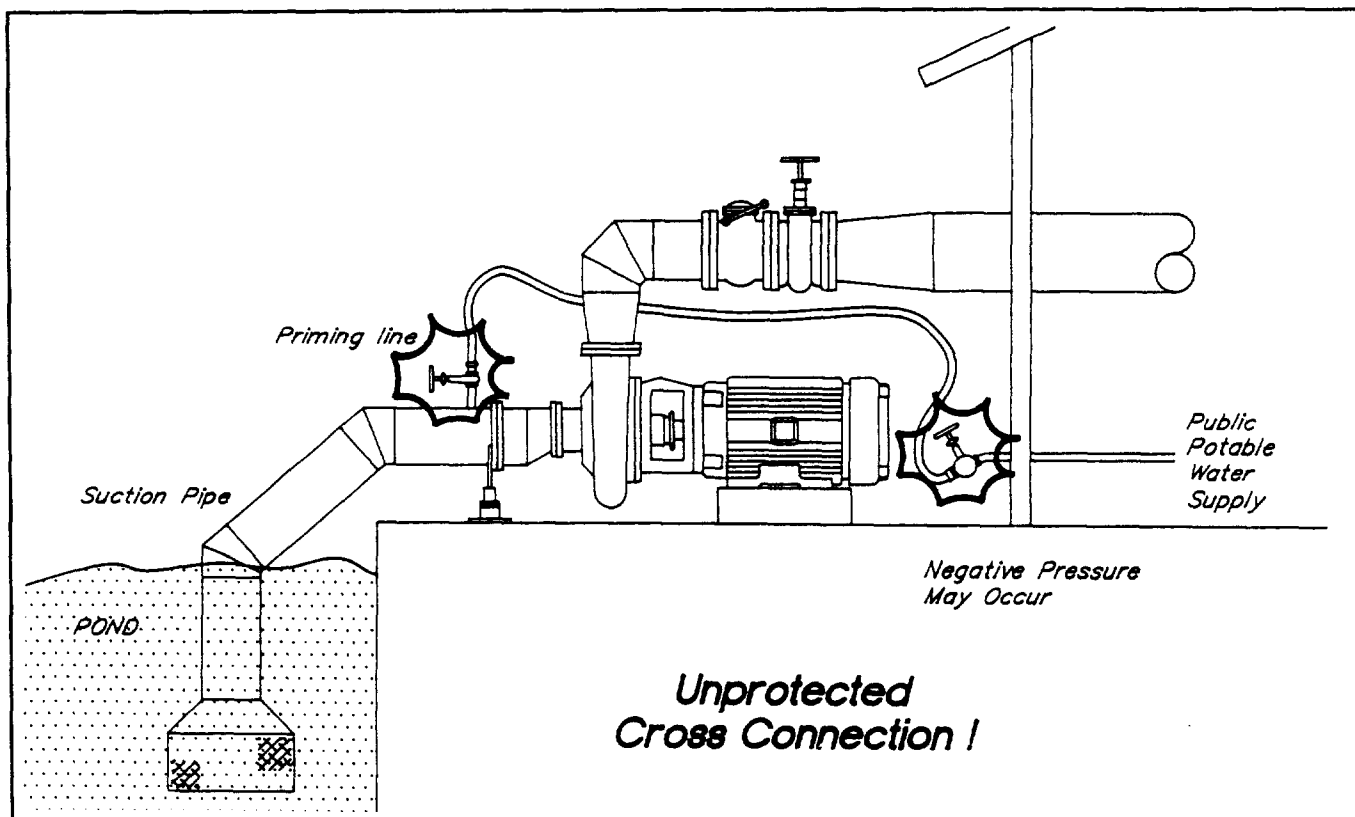


Figure 1-11: Negative Pressure Created By Pump Suction.

Backsiphonage Backflow

Backsiphonage backflow, also referred to as backsiphonage, is the reverse from normal flow direction in a piping system that is the result of a partial vacuum (negative pressure) within the piping system.

Since backsiphonage is always associated with negative pressure in the piping system, it is important to understand how a vacuum can be produced within a system designed to be under continuous positive pressure.

Booster Pumps

Backsiphonage can result when potable water is connected to the suction side of a pump. Booster pumps may be used in a distribution system when there is a significant change in elevation. They are also used in multiple story buildings to increase water pressure to the upper stories. A booster

pump normally does not create a cross connection itself. However, the hydraulic condition that can occur on the suction side of the pump can cause backsiphonage. Under higher than normal demand on the suction or discharge piping, a partial vacuum can be produced on the suction line of the pump. This condition may induce backsiphonage within the piping system.

The use of potable water for pump priming creates two potentially hazardous conditions (Figure 1-11). First of all, this is an unprotected cross connection with the water in the pond. In addition, the connection to the suction piping may result in negative pressure in the potable water piping.

Figure 1-12 shows a booster pump within a multiple story building. The suction side of the pump can lower a portion of the building water system's pressure to below atmospheric under certain

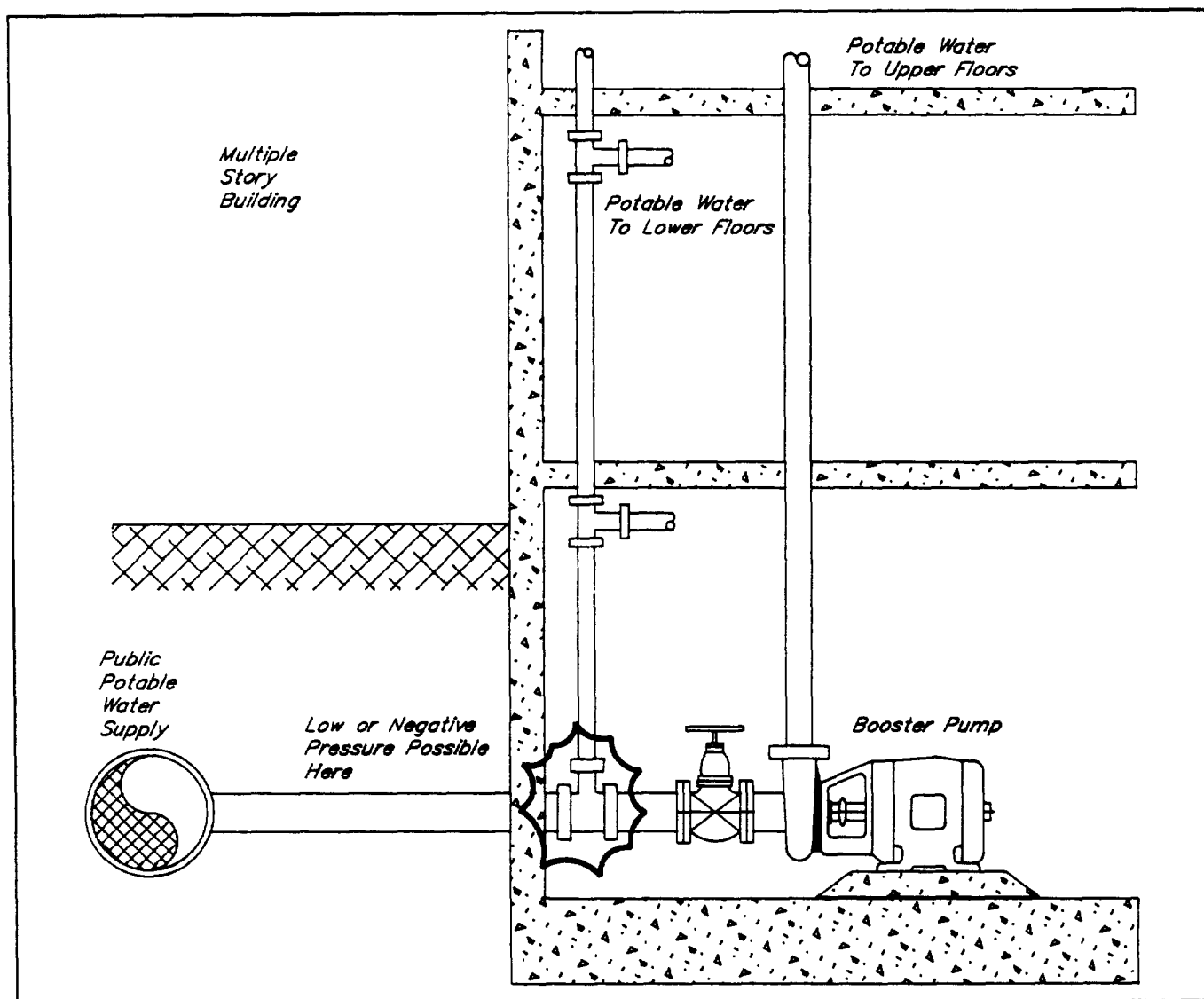


Figure 1-12: Negative Pressure Created By Booster Pump.

conditions. Proper use of a booster pump must always include a low pressure cut-out that shuts the pump off when suction pressure is reduced to a minimum of 20 psi.

Elevated Piping

The supply line to an elevated outlet, such as an overhead tank, can result in backpressure. It is important to realize that elevated piping systems can also produce backsiphonage.

In Figure 1-13, the piping is elevated above the water main source. This condition is very common. If this water main were to drop in pressure below 10 psi, the system would flow back toward the supply. This backflow would induce a partial vacuum at the highest point in the piping system, causing a backsiphonage condition that pulls fluid in the sink over the siphon loop.

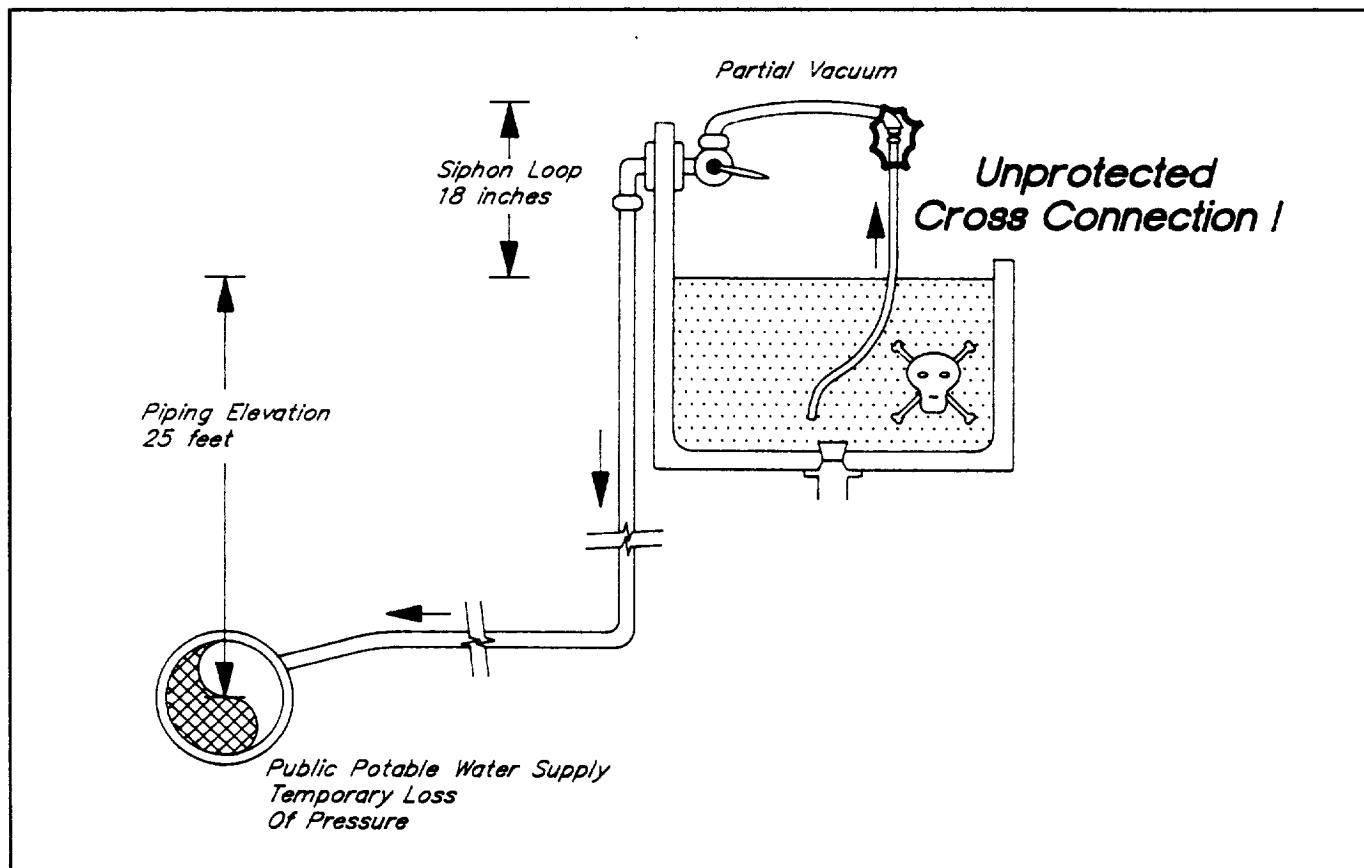


Figure 1-13: Negative Pressure Created By Elevated Piping.

Venturi Effect

Backsiphonage can occur in a water system due to high withdrawals of water. If water flows through a pipeline at a high velocity, the pressure in the pipeline is reduced. Velocities can be increased to a point that a partial vacuum is created along the inside walls of the pipeline. Due to this differential of pressure, water and other fluids can backflow into the pipeline. This condition is known as a **venturi effect**. When there is a venturi effect, backsiphonage will occur wherever a tee, tap, or conduit connects to a line containing water or other fluids which are open to the atmosphere, including leaks in the water line.

Figure 1-14 illustrates how a venturi can be made by an improper application of plumbing materials. The reduced diameter at the tee may produce a partial vacuum, causing backsiphonage from the tank. The pressure at the venturi is lowered as the velocity (flow) through the main line increases.

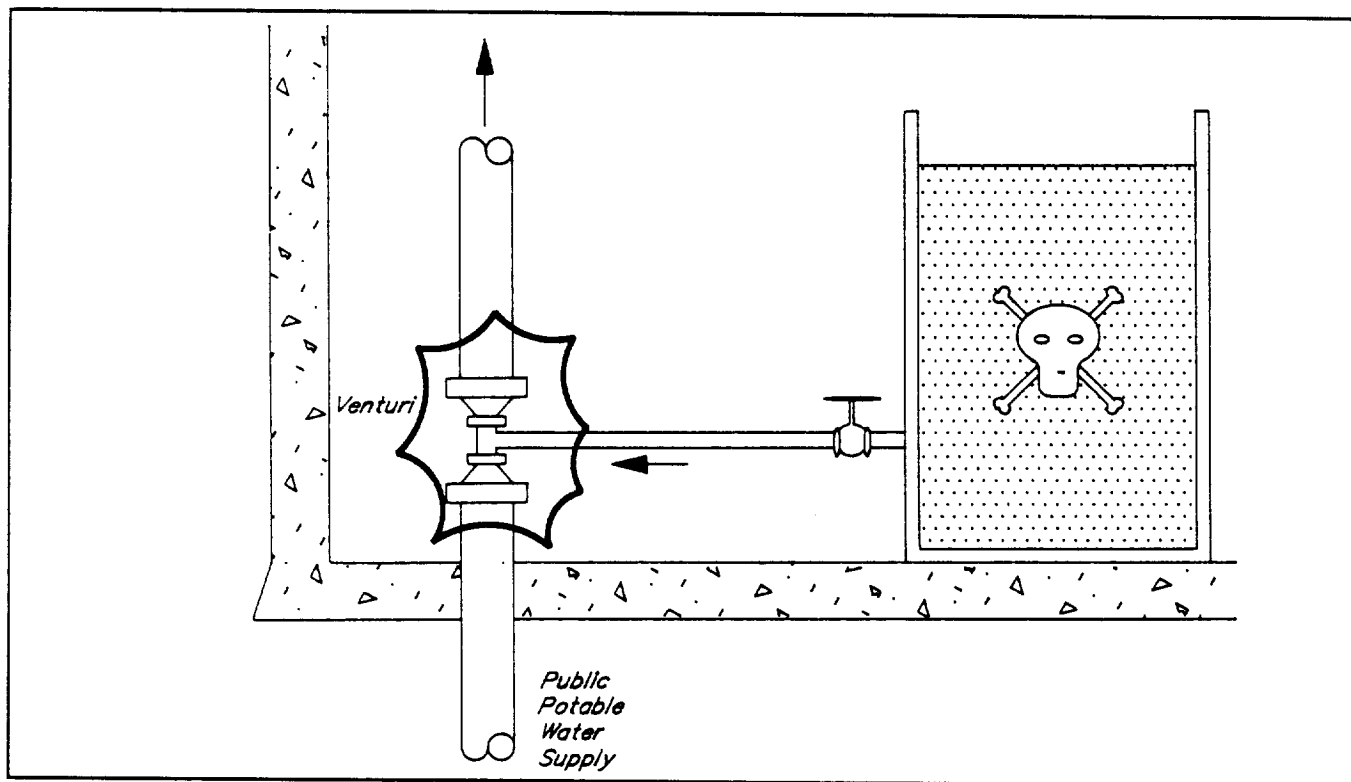


Figure 1-14: Backflow Due To Venturi Effect.

Figure 1-15 illustrates what can occur in a distribution system due to high velocities in pipelines. Under normal flow conditions with the valve at point E open; (dashed line on graph) the distribution system pressure varies from 100 psi where it enters the grid, to 50 psi at the hydrant on the far side of the grid. Under these circumstances, all premises have sufficient pressure and fall below the dashed line.

Let's assume that the hydrant at Point F is opened and the valve at Point E has been accidentally left closed. The supply of water to the hydrant during high demand (solid line on graph) will be restricted due to the closed valve at Point E. Therefore, when the hydrant is opened, the pressure at Point F drops to 0 psi. Now the storage tank at Point B, the top floors of the tall building at Point C, the house and swimming pool at Point D, and the house at Point E all fall above the high demand line.

Now the pressure in the main is reduced to a point where it is lower than those areas that fall above the high demand line. The higher pressure areas tend to flow toward the lower pressure areas, causing a potentially serious backsiphonage condition.

To underscore the high potential for backflow within elevated piping systems, consider illustration 1-15. If system pressure is lost due to the open hydrant, the pressure head normally available to the system falls below the higher portions of the system near the hydrant. Under this condition, a combination of backpressure and backsiphonage conditions would cause backflow to occur. Used and/or contaminated water from the various facilities would return to the potable water system. However, this situation does not need to occur every time there is a significant unscheduled drop in system pressure. If this system (Figure 1-15) had an adequate cross connection control program,

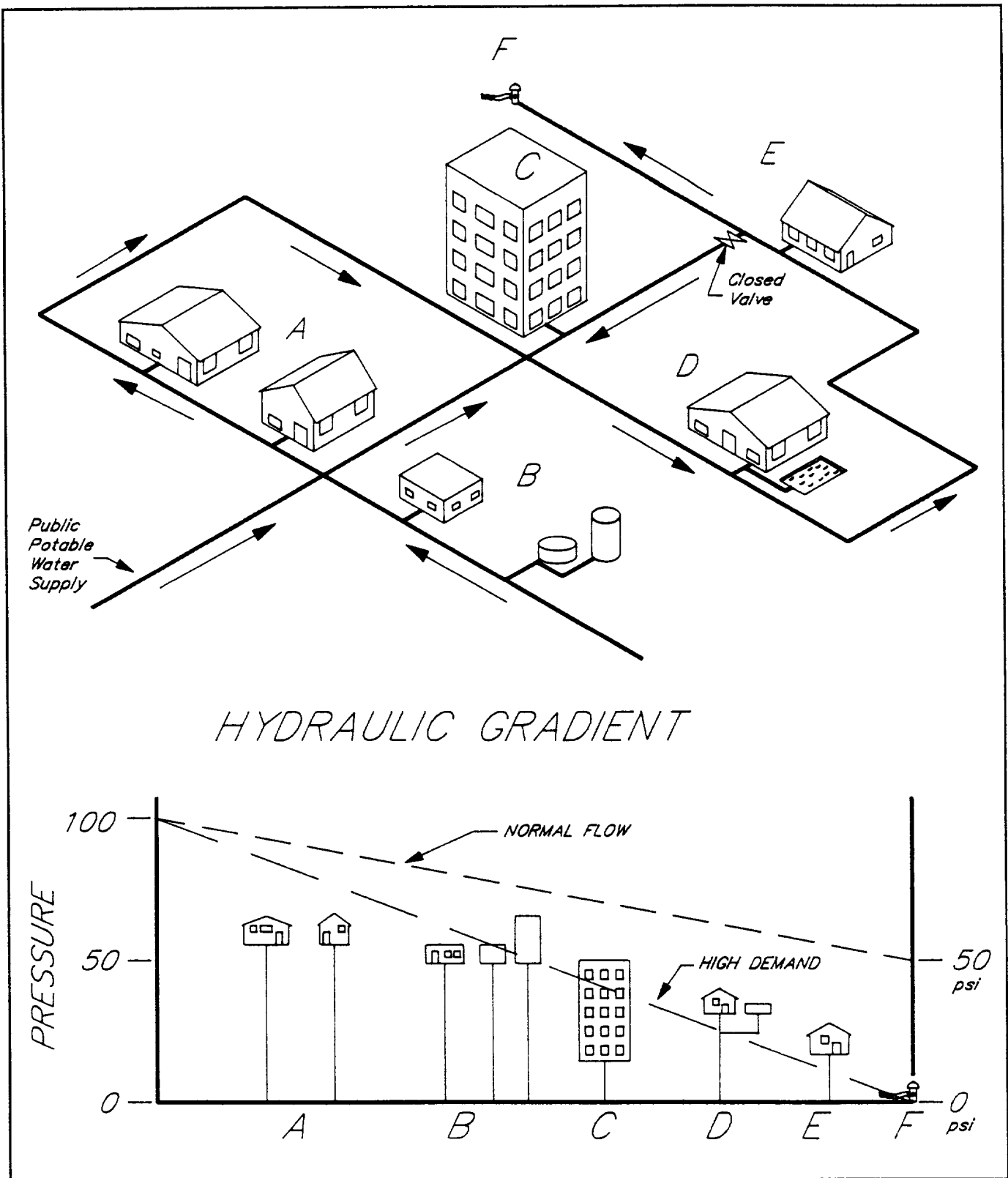


Figure 1-15: Backflow Resulting From High Velocities.

- Potable water booster pumps or any potable water connection to the suction side of a pump.
- Elevated piping (the source of water is significantly below the point of use).
- Undersized piping or fittings that create a localized restriction or venturi.

Notes:

Section 2

Types Of Backflow Prevention Assemblies

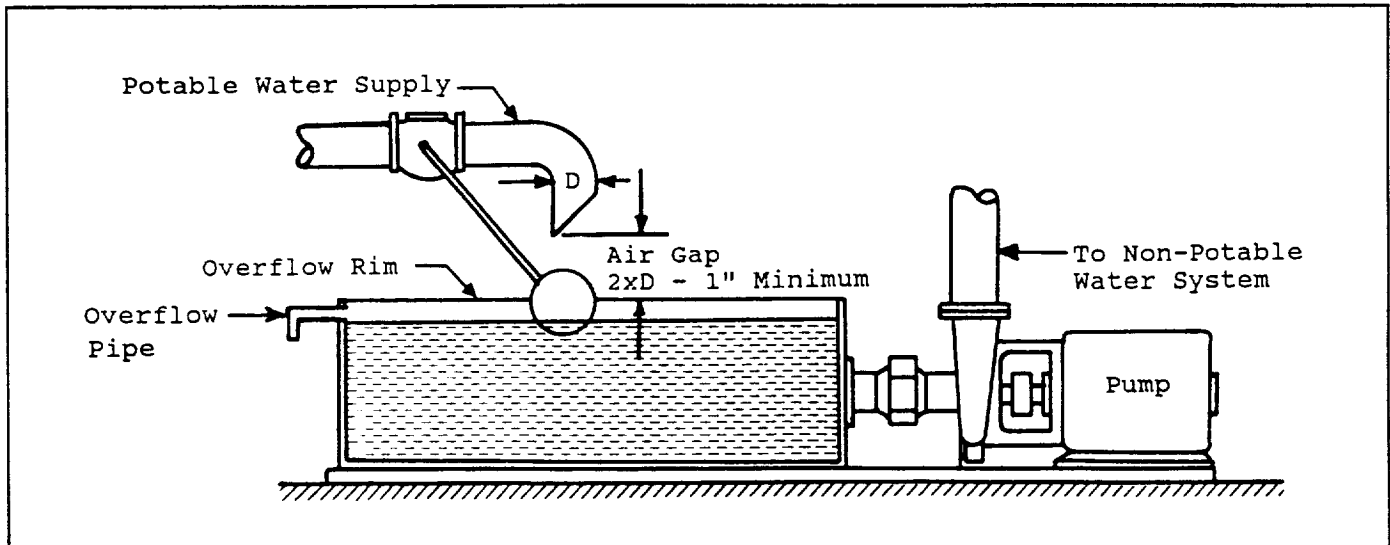


Figure 2-1: Air Gap For Makeup Tank

Approved Air Gap Separation

An approved air gap is a physical separation between the free flowing discharge end of a potable water supply pipeline, and the overflow rim of an open or nonpressure receiving vessel. These separations must be vertically orientated a distance of at least twice the diameter of the inlet pipe, but never less than one inch. When located near walls, the air gap separation must be increased. If splashing is a problem, attach tubular screens or cut the supply line outlet at an angle. If the supply line is cut at an angle, measure the air gap distance from the bottom of the angle. Hoses are not allowed.

In most instances, a well-designed and properly maintained air gap is the best means available for protection against backflow. However, an air gap is not always practical, and it is vulnerable to bypass arrangements which nullify its effectiveness. For these reasons an air gap separation is only required in specific cases where extremely hazardous conditions exist. Figure 2-1 gives an example of an approved air gap. A bypass, such as a line installed between the potable water supply and tank outlet, would nullify this air gap. To insure the effectiveness of air gaps used in lieu of approved backflow assemblies, an inspection shall be included in the yearly testing program for backflow prevention assemblies.

Mechanical Protective Assemblies

Mechanical assemblies used in the prevention of backflow are separated into four basic types:

- Reduced Pressure Backflow Assemblies (RPBA) including Reduced Pressure Detector Assemblies (RPDA).
- Double Check Valve Assemblies (DCVA) including Double Check Detector Assemblies (DCDA).
- Pressure Vacuum Breaker Assemblies (PVBA).
- Atmospheric Vacuum Breakers (AVB).

Design and material specifications for DCVAs and RPBAs can be found in AWWA standard C510-89, Standard for Double Check Valve Backflow Prevention Assembly, and C511-89, Standard for Reduced Pressure Backflow Prevention Assembly. In addition, design and material specifications for RPBAs, RPDAs, DCVAs, DCDAs, PVBAs, and AVBs can be found in the University of Southern California Foundation for Cross Connection Control and Hydraulic Research Manual of Cross Connection Control. Local authorities may have stricter standards of acceptance than those at state or provincial levels. In that case, the local standards will prevail.

All in-line testable assemblies consist of the backflow prevention unit and two resilient seated shutoff valves. These shutoff valves will normally be full port ball valves on assemblies measuring two inches or less. Assemblies measuring more than two inches normally use resilient wedge (RW) gate valves. The assembly's manufacturer must furnish these shutoff valves as part of the complete assembly. Older assemblies which do not have full port ball valves or resilient wedge gate valves as shutoff valves shall be allowed to retain these valves as part of the assembly, as long as they allow for proper testing. If they fail to allow for proper testing, however, they shall be replaced with full port ball valves or resilient wedge gate valves, as appropriate.

Reduced Pressure Backflow Assembly (RPBA)

The reduced pressure backflow assembly consists of two independently acting spring loaded check valves separated by a spring loaded differential pressure relief valve, two resilient seated shutoff valves, and four properly located, resilient seated test cocks. This assembly shall be installed as a unit furnished by the manufacturer. During normal operation, the pressure between the two check valves, the zone of reduced pressure, is maintained at a lower pressure than the supply pressure. If either check valve leaks, the differential pressure relief valve maintains a differential pressure of at least two (2) psi between the supply pressure, and the zone between the two check valves, by discharging water to atmosphere.

The RPBA is normally used in locations where an approved air gap is impractical. The assembly is effective against backflow caused by backpressure and backsiphonage, and is used to protect the potable water system from substances that constitute a high hazard. Figures 2-2 through 2-7 on the following pages provide examples of RPBAs and their internal construction.

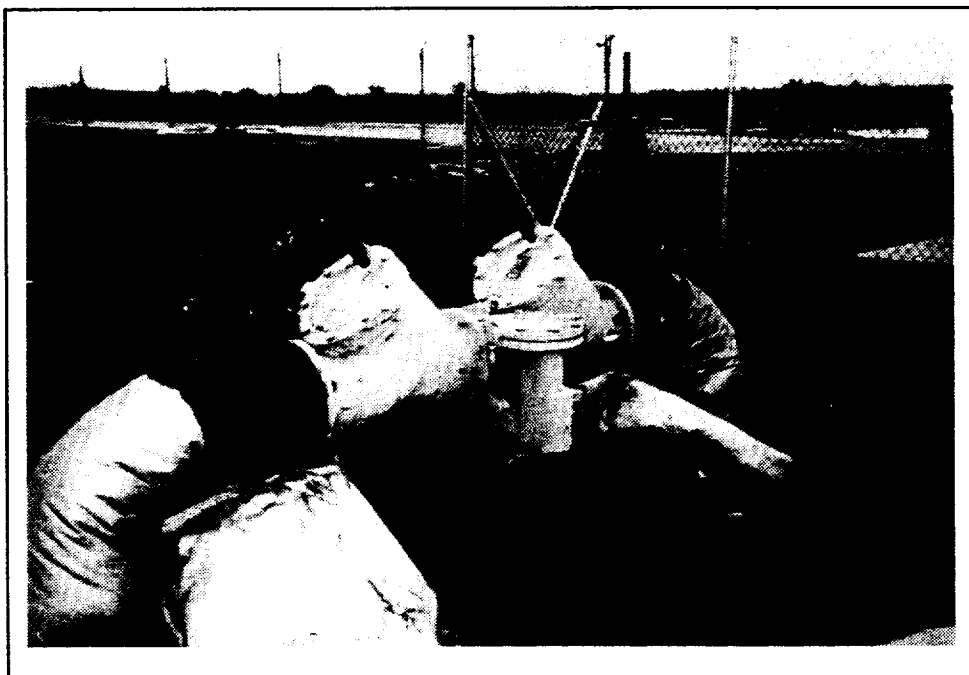


Figure 2-2: Typical Large Size Reduced Pressure Backflow Assembly.

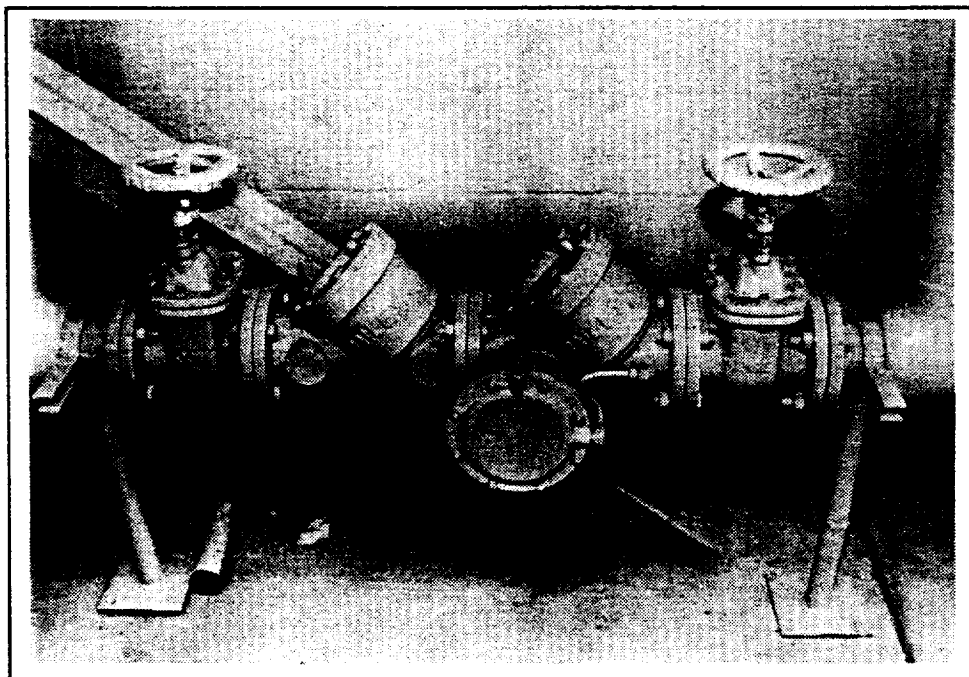


Figure 2-3: Typical Large Size Reduced Pressure Backflow Assembly.

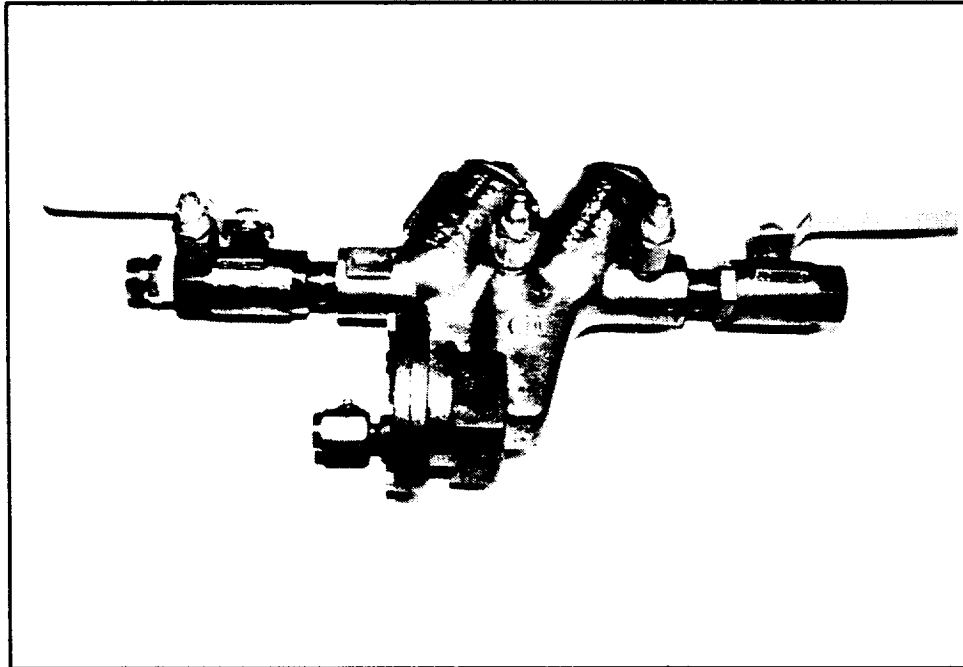


Figure 2-4: Typical Small Size Reduced Pressure Backflow Assembly.

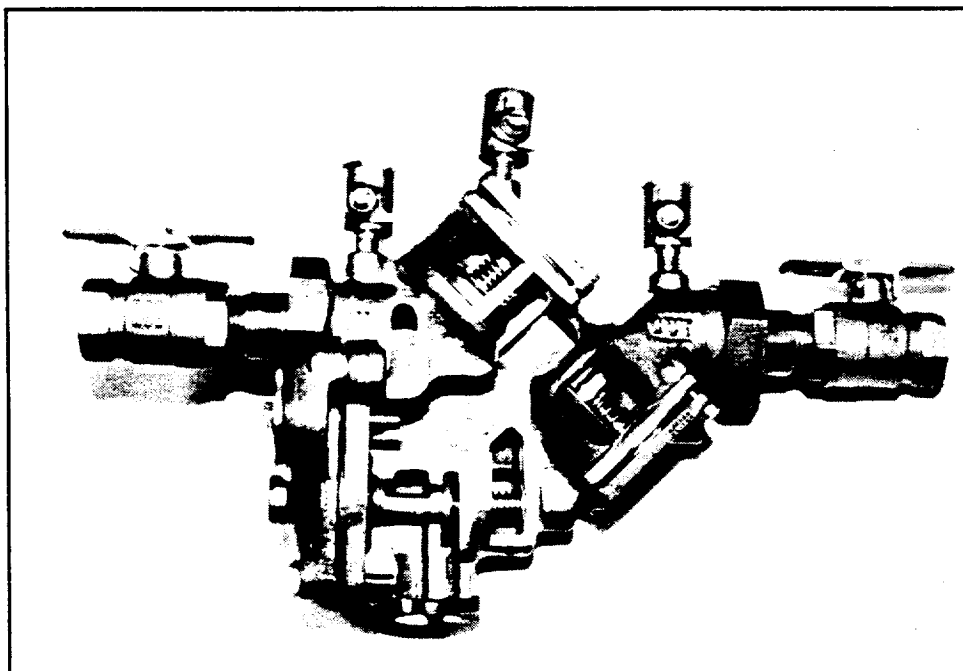


Figure 2-5: Typical Small Size Reduced Pressure Backflow Assembly.

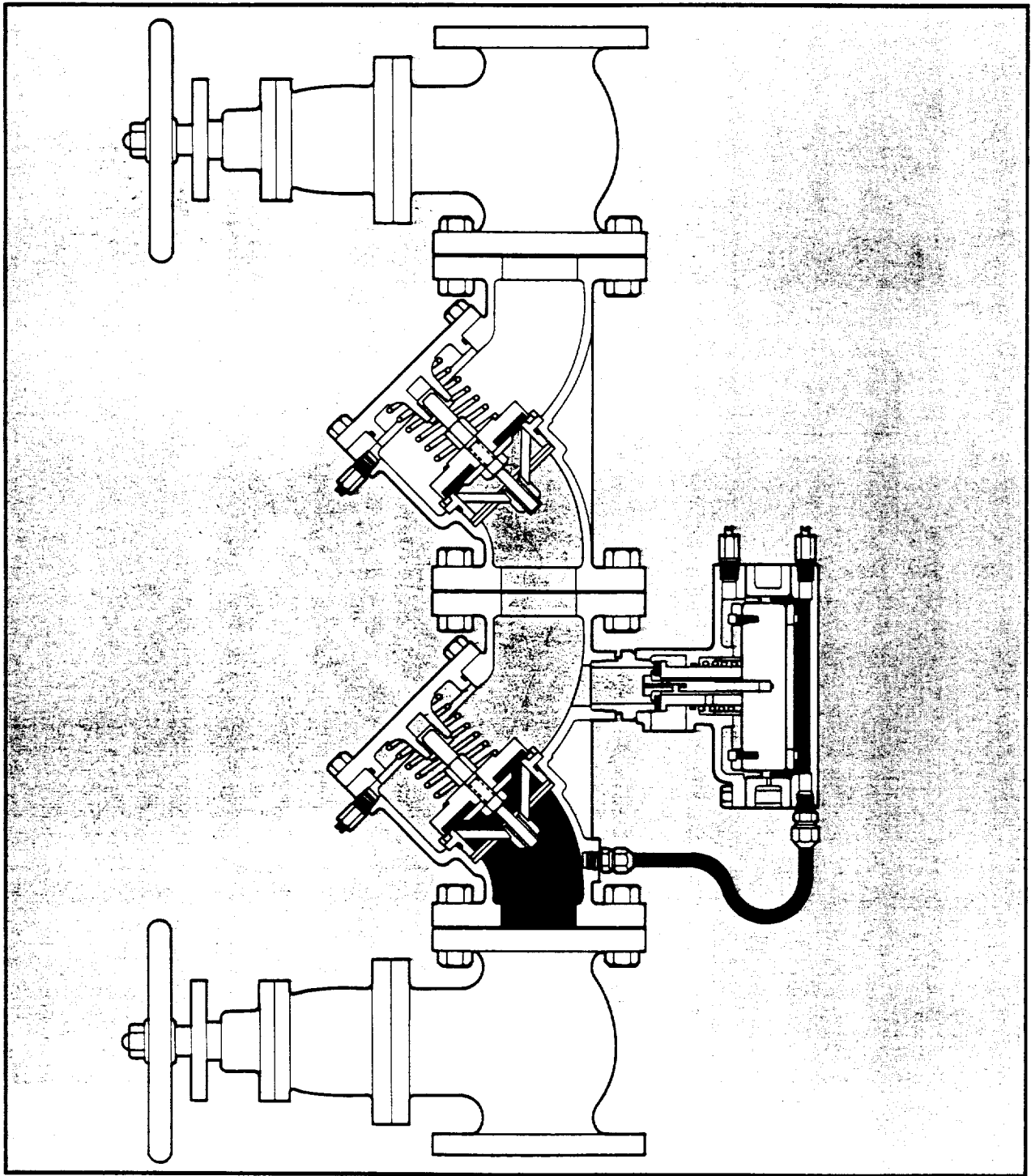


Figure 2-6: Cross Section Of Large Size RPBA.

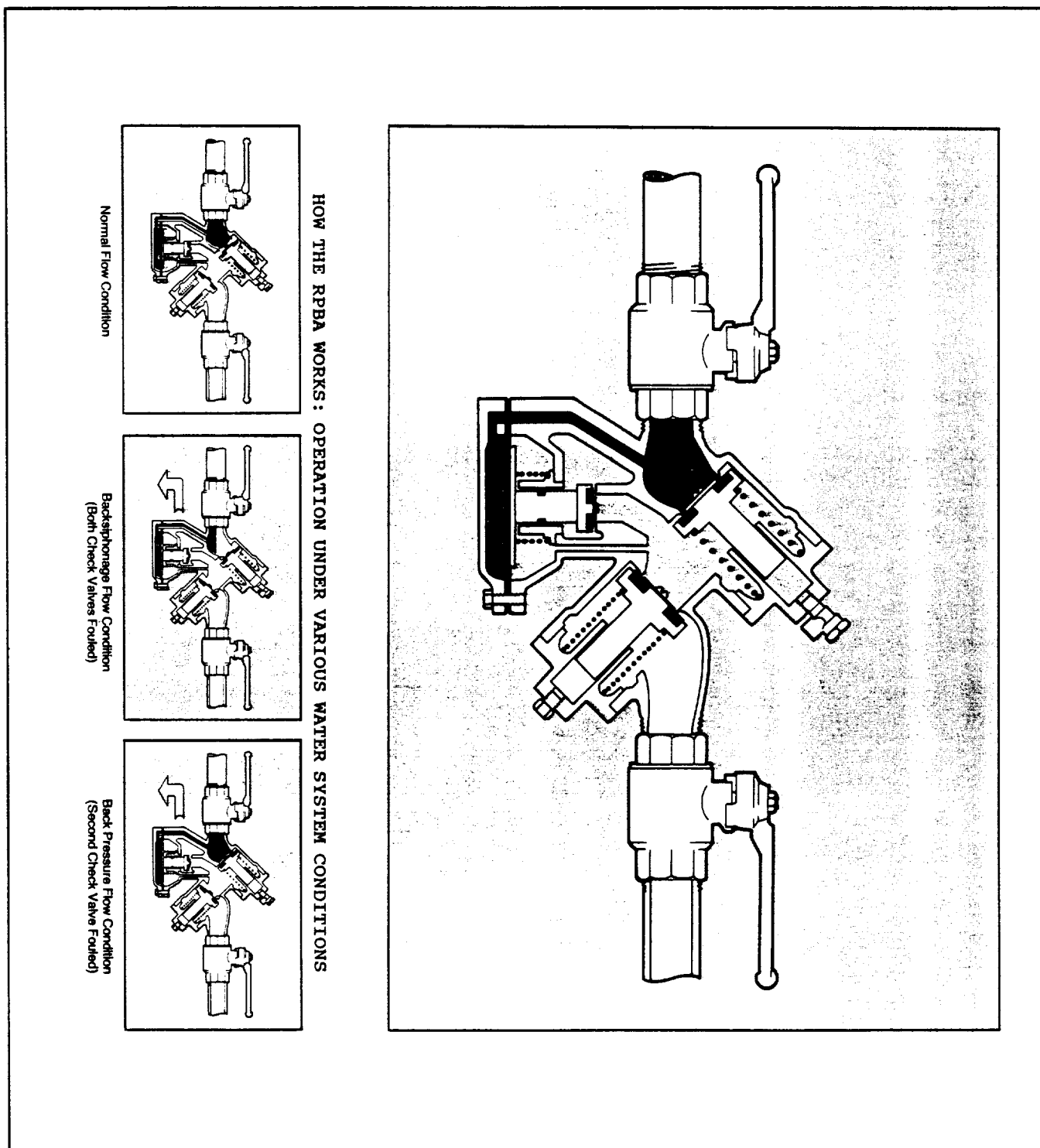


Figure 2-7: Cross Section Of Small Size RPBA.

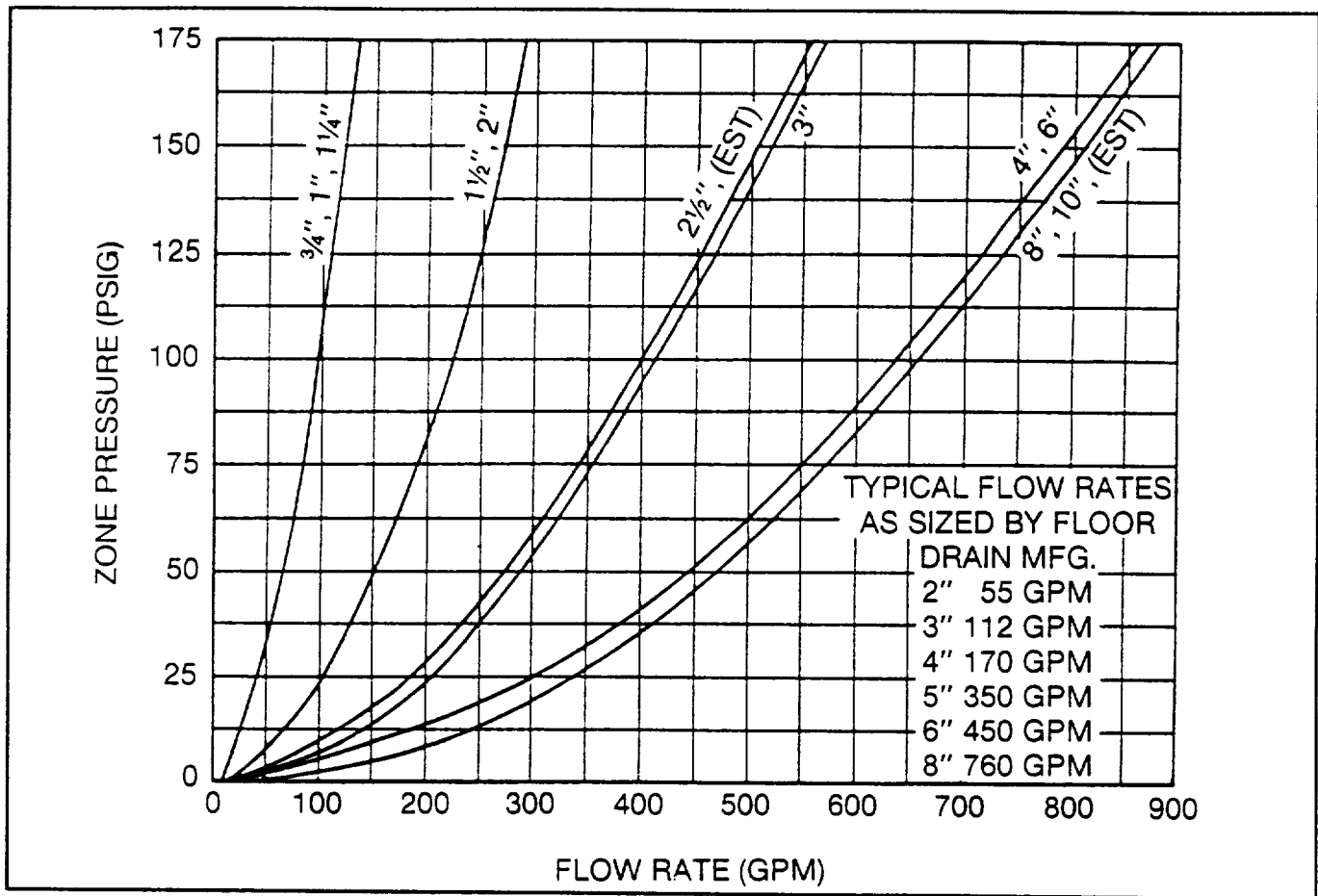


Figure 2-8: Relief Valve Discharge Rates For Reduced Pressure Backflow Assemblies.

RPBA Installation (Also refer to Section 7)

1. It is critical that all RPBA's be installed with adequate space consideration for testing, repair and maintenance (see Figure 2-9). All assemblies require a minimum clearance for removal of pins, check assemblies, and/or relief valves. Again, consult the specific manufacturer's installation instructions prior to installation. **In all cases, consult with the responsible local water purveyor for their specific space and installation requirements.** All RPBA's shall be tested after installation and repairs to insure their proper installation and satisfactory operation.
2. An RPBA installed more than five (5) feet above floor or ground level must have a platform under it for the tester or maintenance person to stand on. The platform must comply with all applicable safety standards and codes in effect (See Section 5).
3. When installed in an enclosure, adequate space consideration must be given for proper testing and maintenance. An RPBA shall be installed outside any enclosure or hooded area containing fumes that are corrosive, toxic, or poisonous. They shall not be installed in a pit or trench below ground level, or in other areas where they may be flooded. Flooding of the pit or area could result in a direct cross connection through the relief valve port. Semi-buried pits may be acceptable (consult the responsible local water purveyor) if the RPBA is installed above the ground or maximum flood level with an approved air gap between the relief valve and

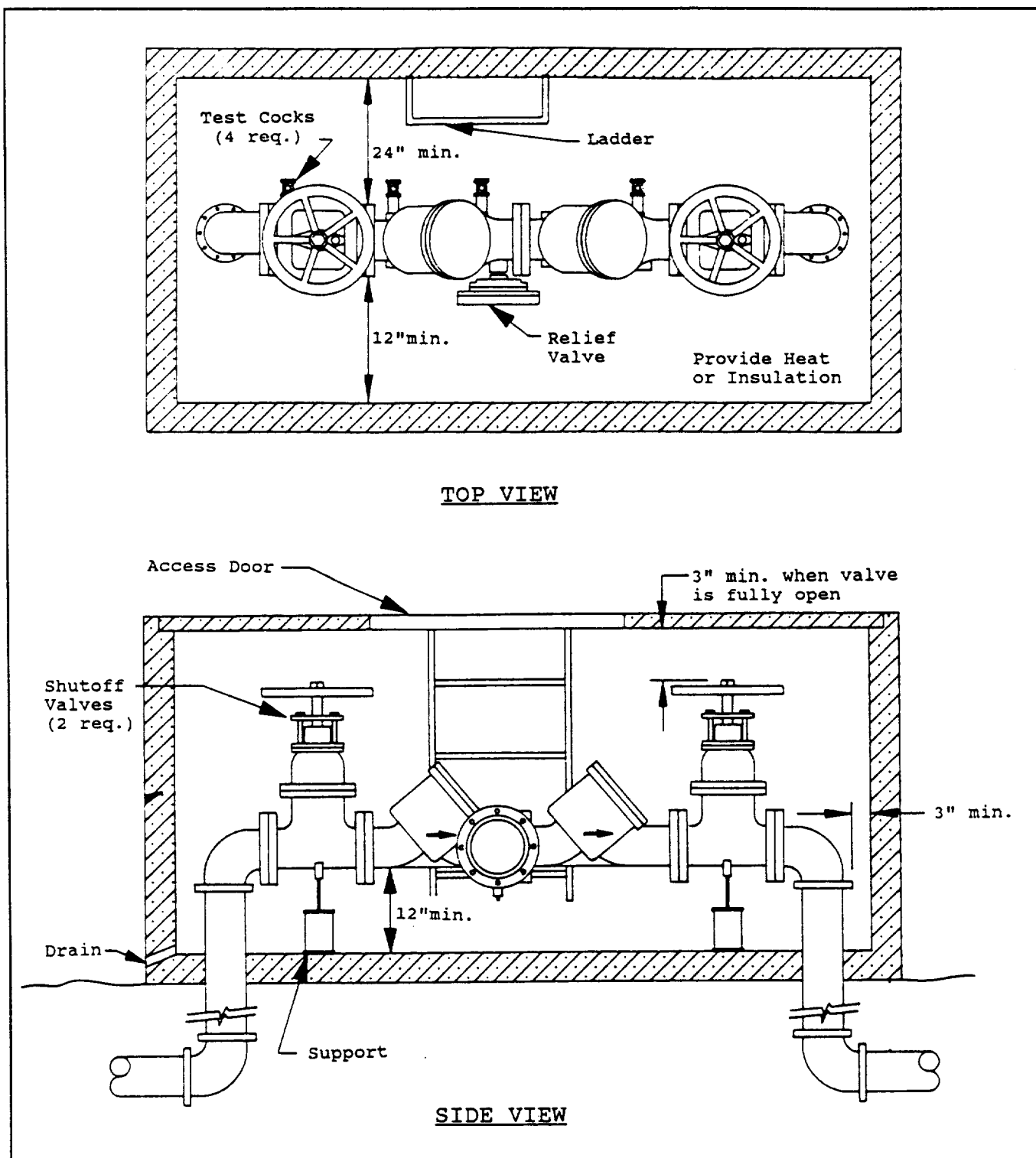


Figure 2-9: Minimum Clearances For RPBA Installation.

a daylight drain. The daylight drain from above grade or semi-buried vault must:

- Be able to be bore sighted.
- Be installed above the ground or maximum flood level, whichever is higher.
- Be able to reasonably handle the volume of water that potentially could be discharged from the relief valve port (see chart in Figure 2-8).

In all cases, whenever access to a vault is required, follow and comply with state and local safety requirements regarding confined space entry (see Section 5).

4. An RPBA shall only be installed in a horizontal configuration. Any other orientation may deter the RPBA from preventing backflow.
5. Be careful to insure that the assembly is not installed where the temperature and pressure is maintained above the assembly's rated and labeled capacities.
6. Thermal water expansion and/or water hammer downstream of the assembly can cause excessive pressure. To avoid possible damage to the system and assembly from this situation, use water hammer arresters or surge protectors.
7. When the RPBA is located inside a building, it shall be installed in a location where both the occasional spitting from the relief valve port, and the possible constant discharge during a fouled check situation, will not be objectionable. It must be emphasized that a drainage system which will reasonably handle the volume of water that could potentially be discharged from the relief valve must be provided in the installation. The chart in Figure 2-8 shows estimated relief valve discharge rates.
8. Because of the inherent design of a reduced pressure backflow assembly, fluctuating supply pressure on an extremely low flow or static flow condition may cause nuisance dripping and potential fouling of the assembly. In a static condition (i. e. an RPBA on the make-up water line to a boiler), the zone of reduced pressure between the check valves must be maintained at a 2.0 psi or greater differential below the incoming supply pressure. Depending on the degree of fluctuating supply pressure, the assembly may discharge water from time to time. This nuisance discharge can potentially foul the first check valve. While not effective in all cases, the installation of a soft seated check valve immediately ahead of the RPBA will often hold the pressure constant to the assembly in times of fluctuating supply pressure.
9. Size the assembly hydraulically to avoid excessive pressure loss. The head loss is not necessarily proportional to flow. Some assemblies have a high head loss at low flows and low head loss at high flows.
10. In areas where debris content in the water supply is high, good plumbing practice recommends a strainer with blowout tapping ahead of the assembly.
11. Assemblies 2½ inches and larger shall have support blocks to prevent flange damage. Consult the specific manufacturer for the recommended location of supports.
12. ***Thoroughly flush the lines before installing the assembly.*** Years of experience have shown that most "failure to test satisfactory" results in new installations are caused by debris fouling one of the check valves or the relief valve.

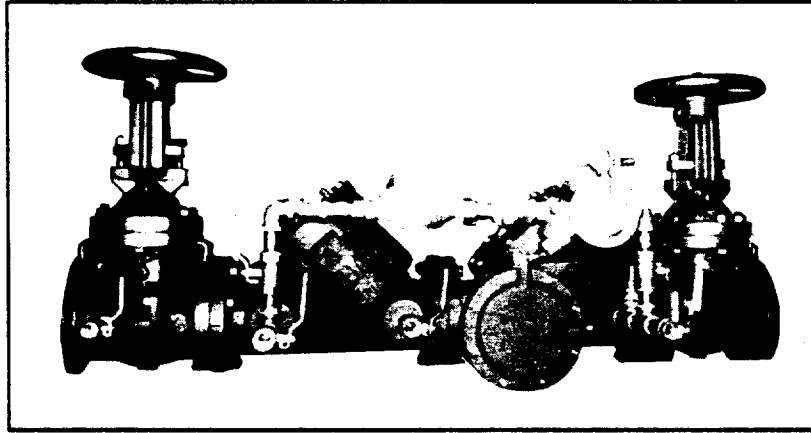


Figure 2-10: Typical Reduced Pressure Detector Assembly.

Reduced Pressure Detector Assembly (RPDA)

The reduced pressure detector assembly (Figure 2-10) operates and functions exactly as a reduced pressure backflow assembly, with the addition of a factory installed (typically $\frac{3}{4}$ inch) bypass feature. This bypass feature, designed to monitor low flows on high hazard fire systems, is used to detect the unauthorized use of water allocated for fire protection, and/or to detect leaks in the fire system. It includes a water meter on the bypass line. Since the bypass, in effect, circumvents the main line RPBA, it includes an approved RPBA, complete with shutoff valves and test cocks.

Installation, maintenance and testing requirements are identical to those for the reduced pressure backflow assembly. Additional consideration in installation must be taken to allow for adequate space to maintain and test the main line assembly as well as the bypass assembly. In addition, some manufacturers use a stronger spring in the number

one check valve of the main line assembly so low flows will pass through the bypass line. If the number one check spring of the main line assembly must be replaced, take care to install the spring designed for the specific RPDA. Consult the specific manufacturer for the correct replacement part. Assemblies with a stronger spring loading must still meet the pressure loss requirements of a standard RPBA.

Double Check Valve Assembly (DCVA)

The Double Check Valve Assembly consists of two internally loaded check valves, either spring loaded or internally weighted, two resilient seated shutoff valves, and four properly located resilient seated test cocks as shown in Figures 2-11 through 2-15. This assembly shall be installed as a unit as furnished by the manufacturer. This assembly is effective against backflow caused by backpressure and backsiphonage, and is used to protect the water system from objectionable substances which may constitute a low hazard.



Figure 2-11: Typical Large Size Spring-Loaded Double Check Valve Assembly.

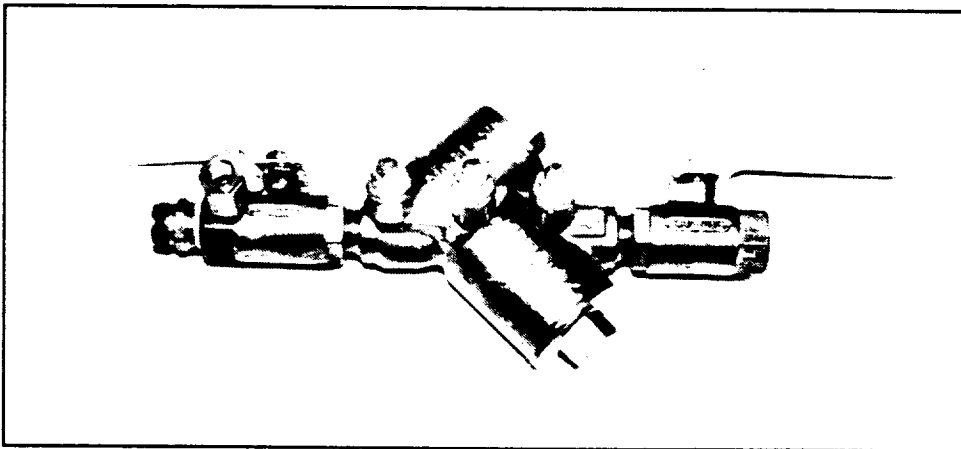


Figure 2-12: Typical Small Size Spring-Loaded Double Check Valve Assembly.



Figure 2-13: Typical Large Size Weighted Double Check Valve Assembly.

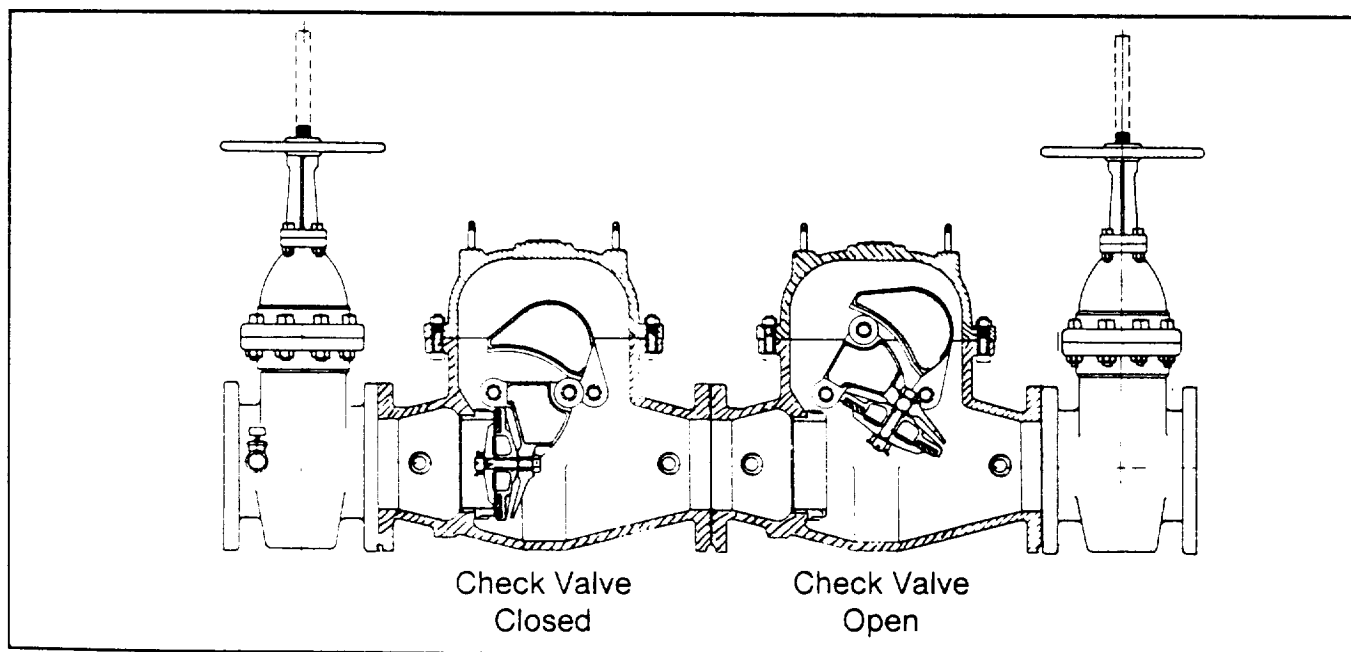
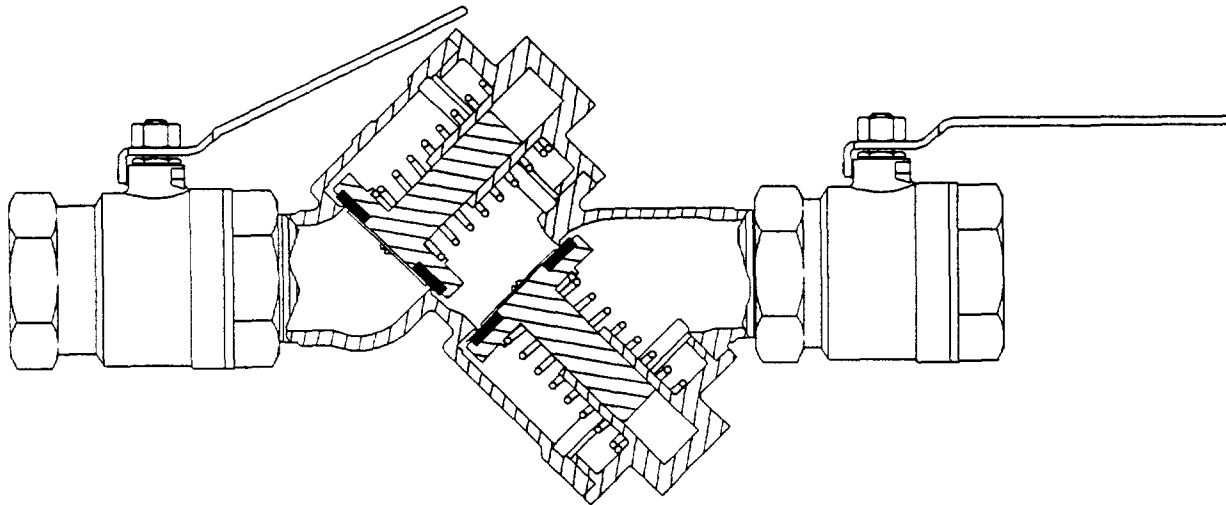
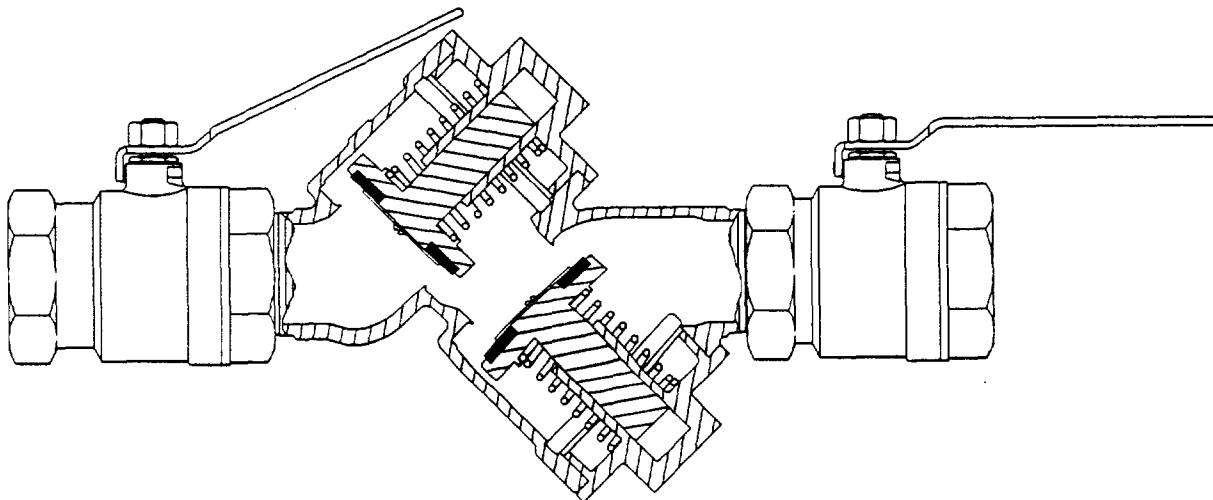


Figure 2-14: Cross Section Of Weighted Double Check Valve Assembly.



**CROSS SECTION OF TYPICAL DCVA
UNDER STATIC CONDITION**



**CROSS SECTION OF TYPICAL DCVA
UNDER FLOWING CONDITION**

Figure 2-15: Cross Sections Of Spring-Loaded Double Check Valve Assembly.

DCVA Installation (Also refer to Section 7)

1. It is critical that all DCVAs be installed with adequate space consideration for testing, repair, and maintenance (see Figures 2-16 and 2-17). All assemblies require a minimum clearance for removal of pins and/or check assemblies. Again, consult the specific manufacturer's installation instructions prior to installation. **In all cases, consult with the responsible local water purveyor for their specific space and installation requirements.** All DCVAs shall be tested after installation and repairs to insure their proper installation and satisfactory operation.
 2. A DCVA installed more than five (5) feet above floor or ground level must have a platform under it for the tester or maintenance person to stand on. The platform must comply with all applicable safety standards and codes in effect (See Section 5).
 3. When installed in a vault, adequate space consideration must be given for proper testing and maintenance. In all vault installations, consult the responsible local water purveyor for their specific requirements. The vault shall be large enough for free access for workers to enter for testing and/or repairing the assembly. This includes adequate clearance all around the assembly for maintenance. Include an adequate hatch in the cover, or complete cover removal, through which personnel may access the vault. Provisions must be made for crane access for removing and installing larger assemblies. Large vaults must also be provided with ladders. Several manufacturer's "Y" pattern assemblies require removal of the number two check valve from the bottom. Space below the assembly must be allowed for this, or the assembly may be installed on its side (see Figure 2-16 and 2-17).
- Check the specific manufacturer's recommendations. **In all cases, whenever access to a vault is required, follow and comply with state and local safety requirements regarding confined space entry (see Section 5).**
4. Unless the DCVA has been evaluated and approved by the authority having jurisdiction, it shall only be installed in a horizontal configuration. Any other orientation may deter the DCVA from preventing backflow.
 5. Be careful to insure that the assembly is not installed where the temperature and pressure is maintained above the assembly's rated and labeled capacities.
 6. Thermal water expansion and/or water hammer downstream of the assembly can cause excessive pressure. To avoid possible damage to the system and assembly from this situation, use water hammer arresters or surge protectors.
 7. Size the assembly hydraulically to avoid excessive pressure loss. The head loss is not necessarily proportional to flow. Some assemblies have a high head loss at low flows and low head loss at high flows.
 8. In areas where debris content in the water supply is high, good plumbing practice recommends a strainer with blowout tapping ahead of the assembly.
 9. Assemblies 2½ inches and larger shall have support blocks to prevent flange damage. Consult the specific manufacturer for the recommended location of supports.
 10. **Thoroughly flush the lines before installing the assembly.** Years of experience have shown that most "failure to test satisfactory" results in new installations are caused by debris fouling one of the check valves.

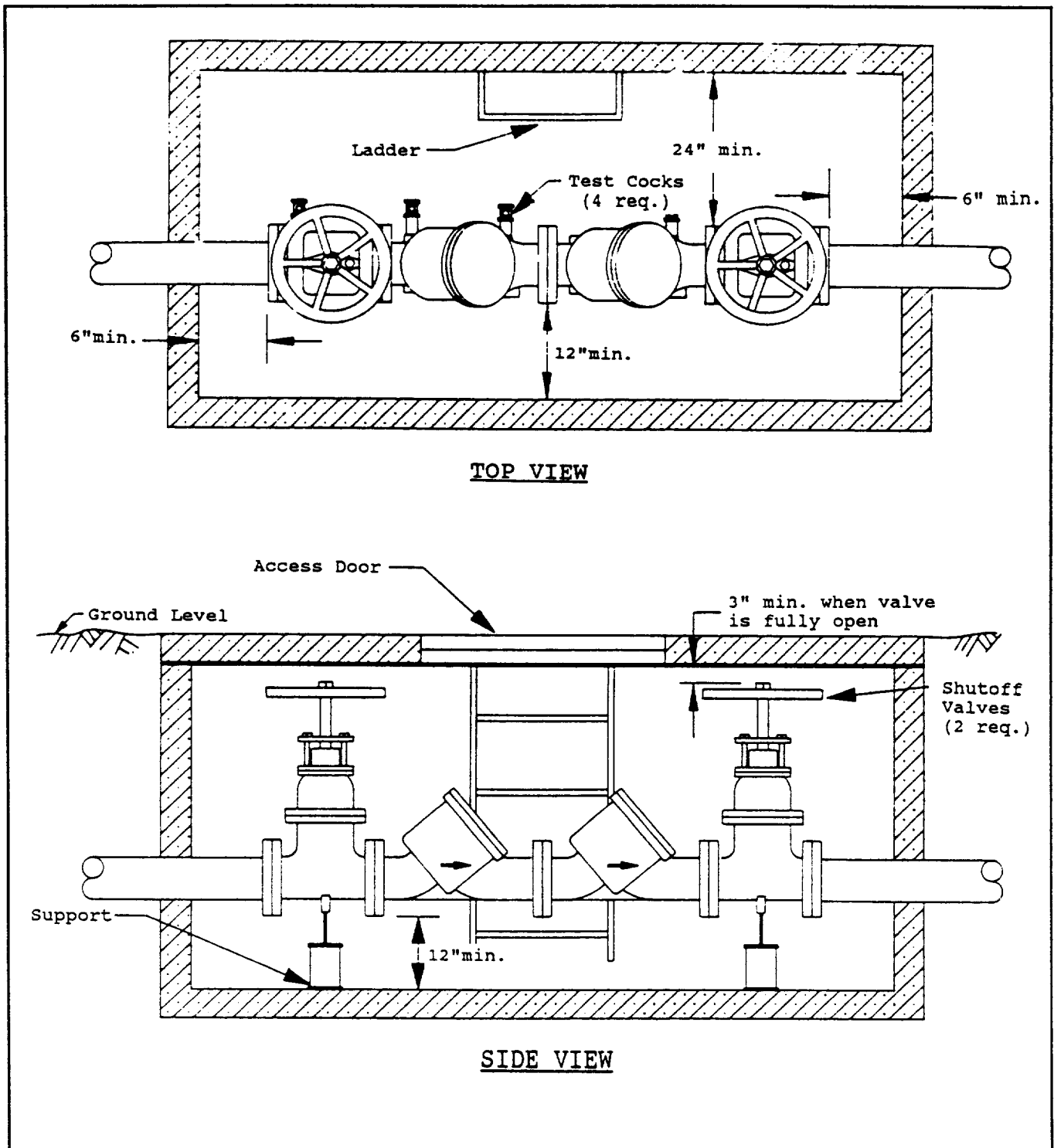


Figure 2-16: Minimum Clearances For Large Size DCVA In Vault.

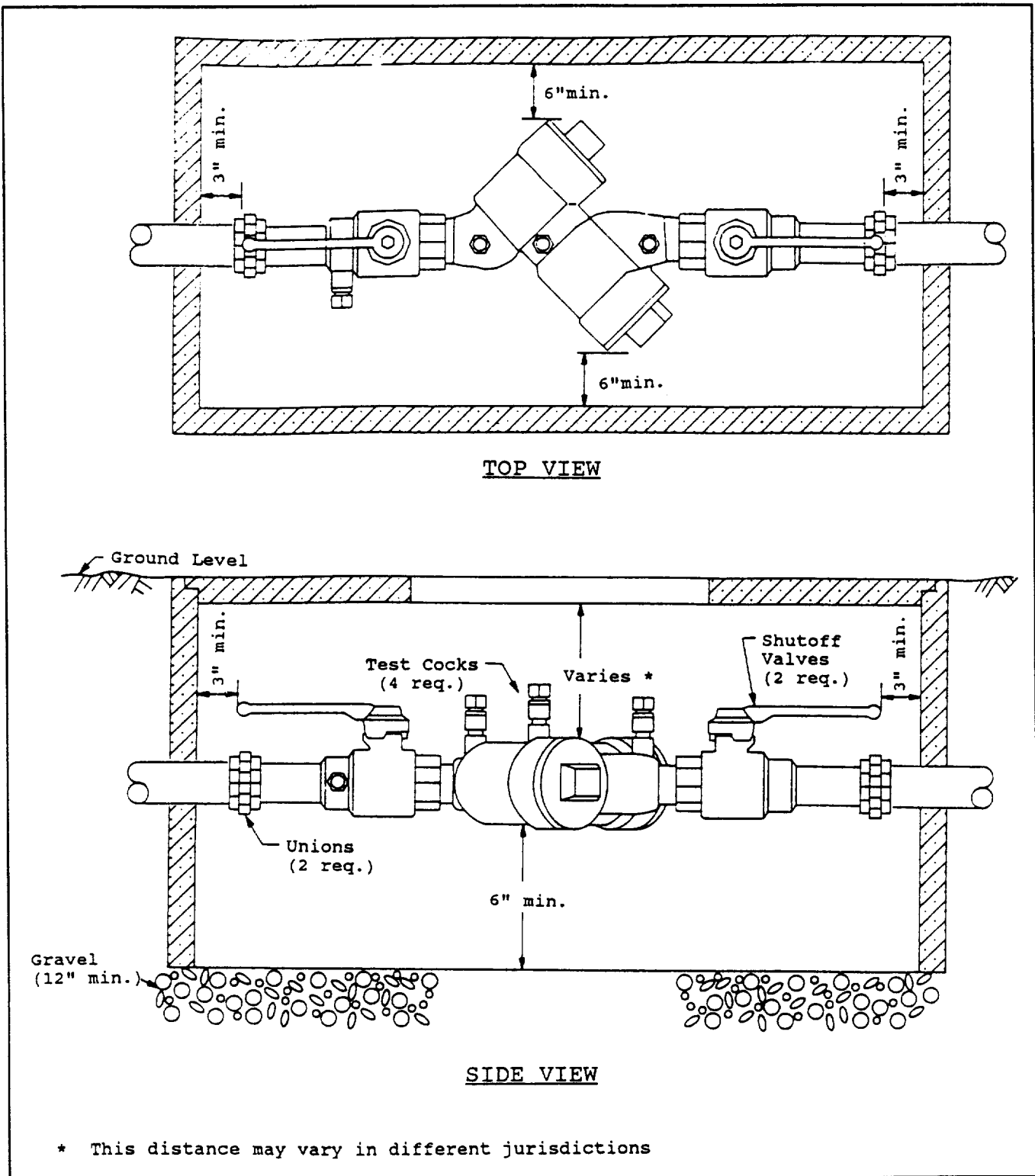


Figure 2-17: Minimum Clearances For Small Size DCVA In Below-Ground Box.

NOTE

Use these guidelines when installing small size DCVAs in below-ground boxes.

1. *Minimum Box Size:*
 - $\frac{3}{4}$ " to 1" Assemblies: 10" X 13"
 - $1\frac{1}{4}$ " to 2" Assemblies: 14" X 20"
2. *Assembly must be installed with test cocks facing up or to one side.*
3. *Sufficient drainage must be provided to prevent assembly from being submerged.*
4. *"Y" pattern DCVA, when installed in a box below ground level, must NOT have the test cocks facing downward.*

Double Check Detector Assembly (DCDA)

The Double Check Detector Assembly operates and functions exactly as the double check valve assembly, with the addition of a factory installed bypass feature (typically $\frac{3}{4}$ inch). This bypass feature, designed to monitor low flows on low hazard fire systems, is used to detect the unauthorized use of water allocated for fire protection, and/or to detect leaks in the fire system. It includes a water meter on the bypass line. Since the bypass, in effect, circumvents the main line DCVA, it includes an approved DCVA, complete with shutoff valves and test cocks (Figure 2-19).

Installation, maintenance, and testing requirements are identical to those for the double check valve assembly. During installation, adequate space must be left to maintain and test the main line assembly as well as the bypass assembly. In addition, some manufacturers use a stronger spring in the main line assembly's number one check valve so low flows will pass through the bypass line. If the number one check spring of the main line assembly must be replaced, take care to install the spring designed for the specific DCDA. Consult the specific manufacturer for the correct replacement. Assemblies with a stronger spring loading must still meet the pressure loss requirements of a standard DCVA.

Pressure Vacuum Breaker Assembly (PVBA)

The Pressure Vacuum Breaker Assembly consists of a spring loaded check valve, an independently

operating air inlet valve, two resilient seated shutoff valves, and properly located resilient seated test cocks as shown in Figure 2-18. Pressure Vacuum Breaker Assemblies are not acceptable for premise or service protection except for lawn sprinkler systems. This assembly is only designed to be effective against backsiphonage, and is used to protect the water system from substances which may constitute a low hazard. It shall be installed as a unit as furnished by the manufacturer. The air inlet valve is internally loaded to the open position, normally by means of a spring, allowing installation of the assembly on the pressure side of a shutoff valve.

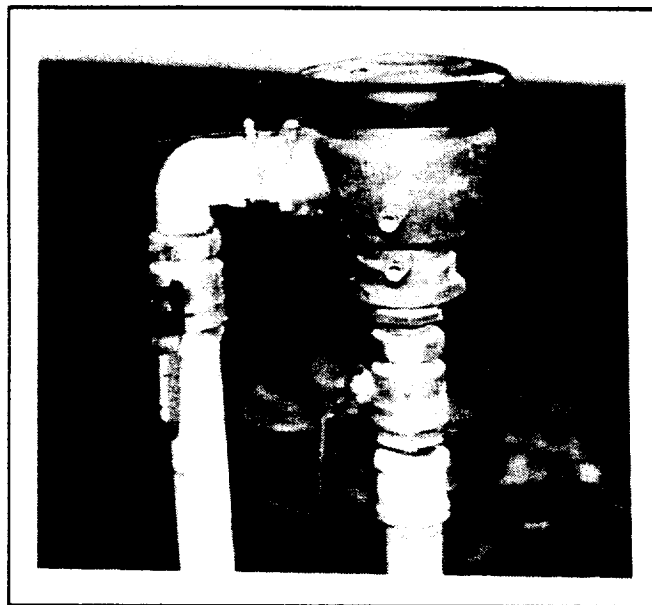


Figure 2-18: Typical Pressure Vacuum Breaker Assembly.

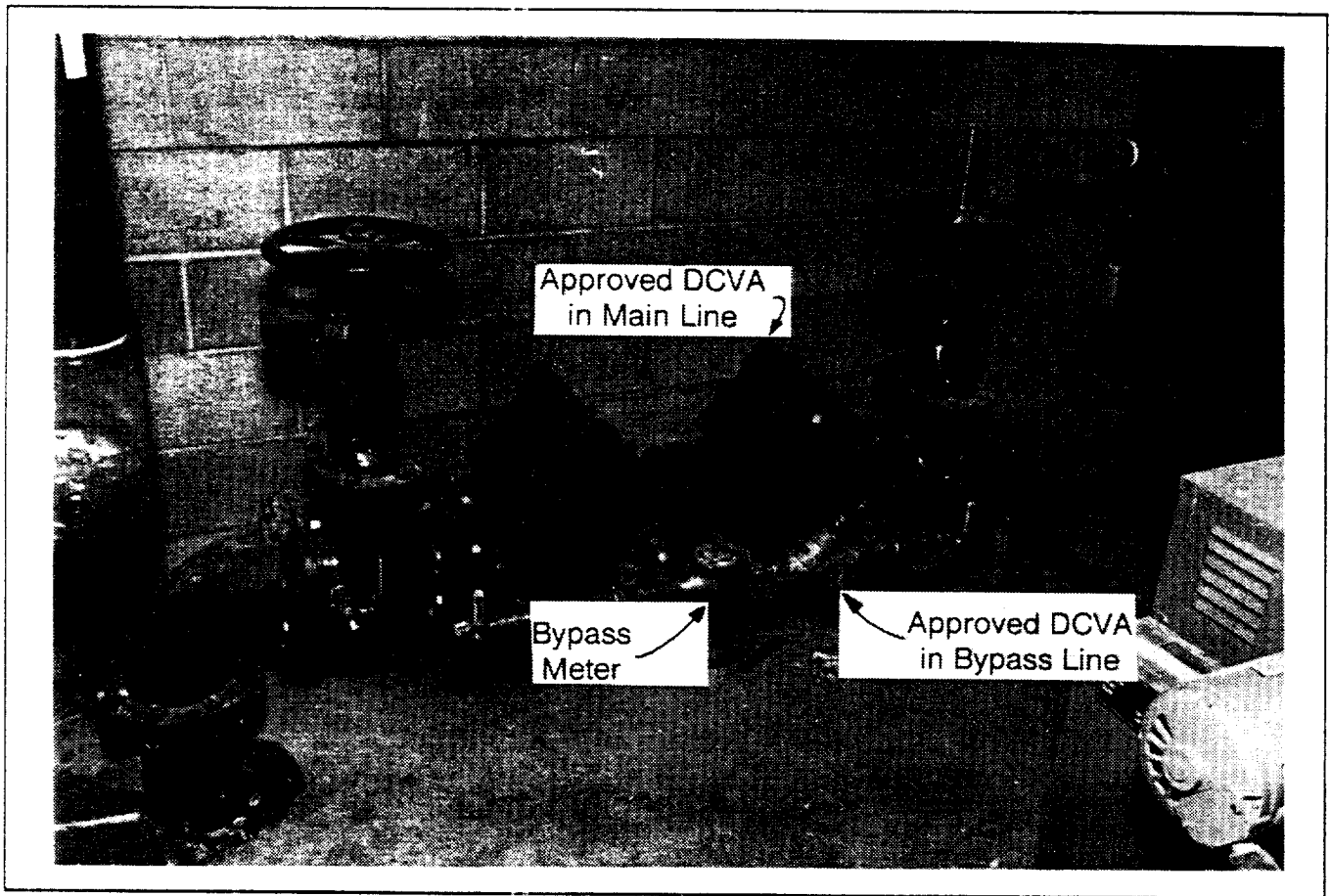


Figure 2-19: Typical Double Check Detector Assembly.

PVBA Installation (Also refer to Section 7)

1. It is critical that all PVBA's be installed with adequate space consideration for testing, repair, and maintenance. All assemblies require a minimum clearance for removal of internal parts. Consult the specific manufacturer's installation instructions prior to installation. **In all cases, consult with the responsible local water purveyor for their specific space and installation requirements.** All PVBA's shall be tested after installation and repairs to insure their proper installation and satisfactory operation.
2. A PVBA installed more than five (5) feet above floor or ground level must have a platform under it for the tester or maintenance person to stand on. The platform must comply with all applicable safety standards and codes in effect (see Section 5).
3. A PVBA shall not be installed in any enclosure or hooded area containing toxic or poisonous fumes, in a pit below ground level, or in other areas where it may be flooded. Flooding of the pit or area could result in a direct cross connection through the air inlet.
4. A PVBA shall only be installed in a vertical configuration a minimum of 12 inches above the highest downstream piping.
5. Be careful to insure that the assembly is not installed where the temperature and pressure is maintained above the assembly's rated and labeled capacities.
6. Water hammer downstream of the assembly can cause excessive pressure. To avoid

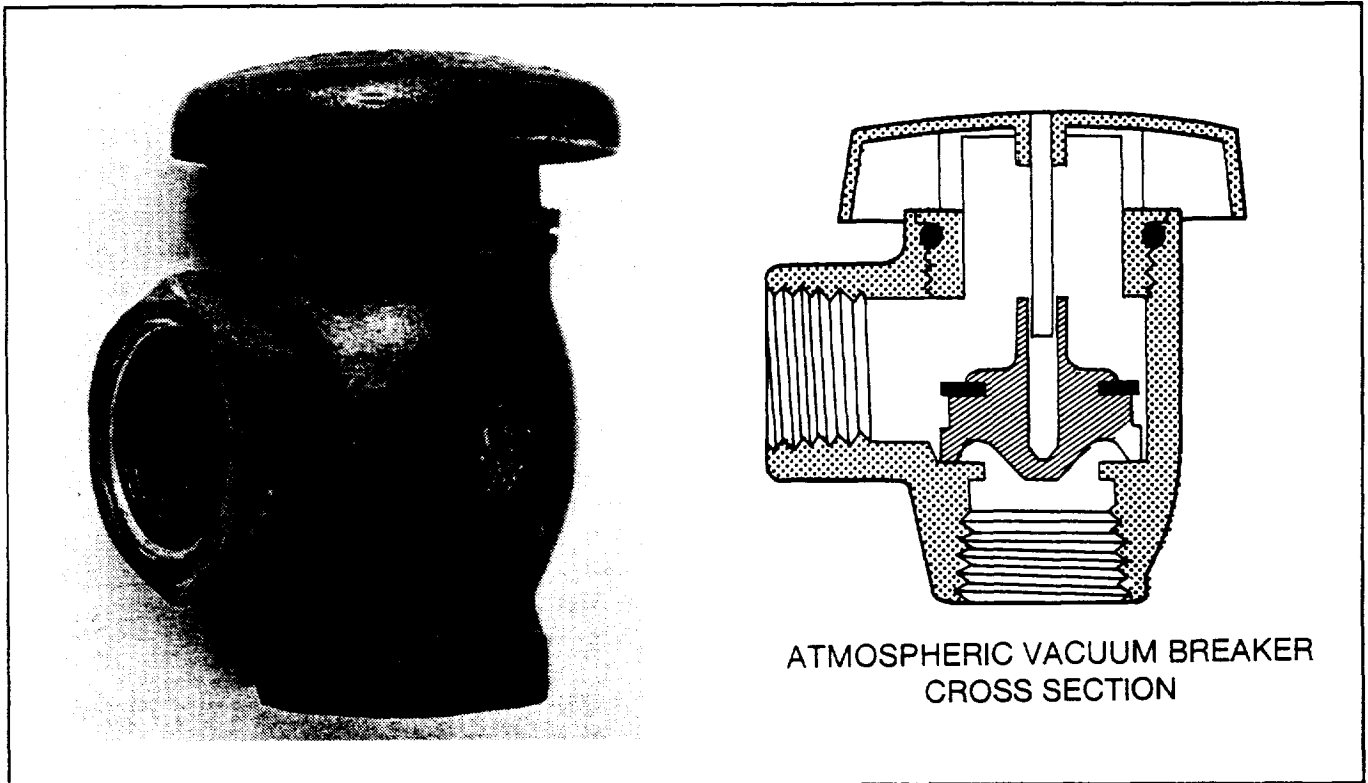


Figure 2-20: Typical Atmospheric Vacuum Breaker.

- possible damage to the system and assembly from this situation, use water hammer arresters or surge protectors.
7. When the PVBA is located inside a building, it shall be installed in a location where the occasional spitting from the air inlet port will not be objectionable. It must be emphasized that a drainage system which will reasonably handle the volume of water that could potentially be discharged from the air inlet port must be provided in the installation.
 8. Size the assembly hydraulically to avoid excessive pressure loss. The head loss is not necessarily proportional to flow. Some assemblies have a high head loss at low flows and low head loss at high flows.
 9. In areas where debris content in the water supply is high, good plumbing practice recommends a strainer with blowout tapping ahead of the assembly.
 10. ***Thoroughly flush the lines before installing the assembly.*** Years of experience have shown that most "failure to test satisfactory" results in new installations are caused by debris fouling the check valve seat or the poppet seat.

Atmospheric Vacuum Breaker (AVB)

The Atmospheric Vacuum Breaker contains a float check (poppet), a check seat, and an air inlet port. The device allows air to enter the water line when the line pressure is reduced to a gauge pressure of zero or below (see Figure 2-20). AVBs are not acceptable for premises or service protection except for lawn sprinkler systems. The air inlet valve is not internally loaded, so the assembly must not be installed on the pressure side of a shutoff valve, or wherever it may be under constant pressure more than 12 hours during a 24 hour period. AVBs are designed only to be effective against backsiphonage, and are used to protect the water system from substances which may constitute a low hazard.

AVB Installation (Also refer to Section 7)

1. It is critical that all AVBs be installed with adequate space consideration for maintenance. All devices require a minimum clearance for removal of internal parts. Consult the specific manufacturer's installation instructions prior to installation. **In all cases, consult with the responsible local water purveyor for their specific space and installation requirements.**
2. An AVB installed more than five (5) feet above floor or ground level must have a platform under it for the maintenance person to stand on. The platform must comply with all applicable safety standards and codes in effect (see Section 5).
3. An AVB shall not be installed in any enclosure or hooded area containing toxic or poisonous fumes, in a pit below ground level, or in other areas where it may be flooded. Flooding of the pit or area could result in a direct cross connection through the air inlet port.
4. An AVB shall only be installed in a vertical configuration, at least 6 inches above all downstream piping.
5. Be careful to insure that the device is not installed where the temperature and pressure is maintained above the devices rated and labeled capacities.
6. When the AVB is located inside a building, it shall be installed in a location where the occasional spitting from the air inlet port will not be objectionable. It must be emphasized that a drainage system which will reasonably handle the volume of water that could potentially be discharged from the air inlet port must be provided in the installation.
7. Size the vacuum breaker hydraulically to avoid excessive pressure loss. The head loss is not necessarily proportional to flow. Some devices have a high head loss at low flows and low head loss at high flows.
8. In areas where debris content in the water supply is high, good plumbing practice recommends a strainer with blowout tapping ahead of the device.
9. **Thoroughly flush the lines before installing the device.**

Table 2-1: Freeze Times Of Protected And Unprotected Pipe

Pipe Size	Wind Speed	Insulation	Ambient Temperature	Minutes To Freeze
3/4"	7.5 mph	0	10°F	2.9
3/4"	7.5 mph	R=8.3	10°F	42.6
2"	7.5 mph	0	10°F	8.9
2"	7.5 mph	R=8.3	10°F	86.4
4"	7.5 mph	0	10°F	19.3
4"	7.5 mph	R=8.3	10°F	142.8

Freeze Protection For Backflow Prevention Assemblies

Backflow prevention assemblies are installed on all types of water services, so it is not always appropriate to shut down a system to drain the assembly. All backflow prevention assemblies that are installed above ground level, or in shallow boxes or vaults, must have provisions for freeze protection in areas where freezing may occur.

Experience has shown that freeze damaged assemblies are often damaged beyond repair, so they must be replaced. Therefore, it is a major consideration to provide freeze protection when initially installing an assembly. Table 2-1 provides test results that show how freeze protection affects the freezing time of pipes.

Services That Require Year Around Operation

In most cases, some type of permanent shelter should be provided for the assembly, or if possible, the assembly should be installed in a building with an adequate source of heat. There are several types of commercially available enclosures that will usually protect the assembly from freezing (see Figure 2-21).

Several considerations must be taken into account if a backflow prevention assembly is installed at the property line, as in the case of premise isolation:

- Electricity may be required for lighting and heaters. Adequate space must be provided and local electrical codes must be satisfied.
- Drainage is required from above ground shelters for reduced pressure backflow assemblies. Refer to Figure 2-8 for proper drain size.
- If the shelter is not removable, room for testing and maintenance must be provided.

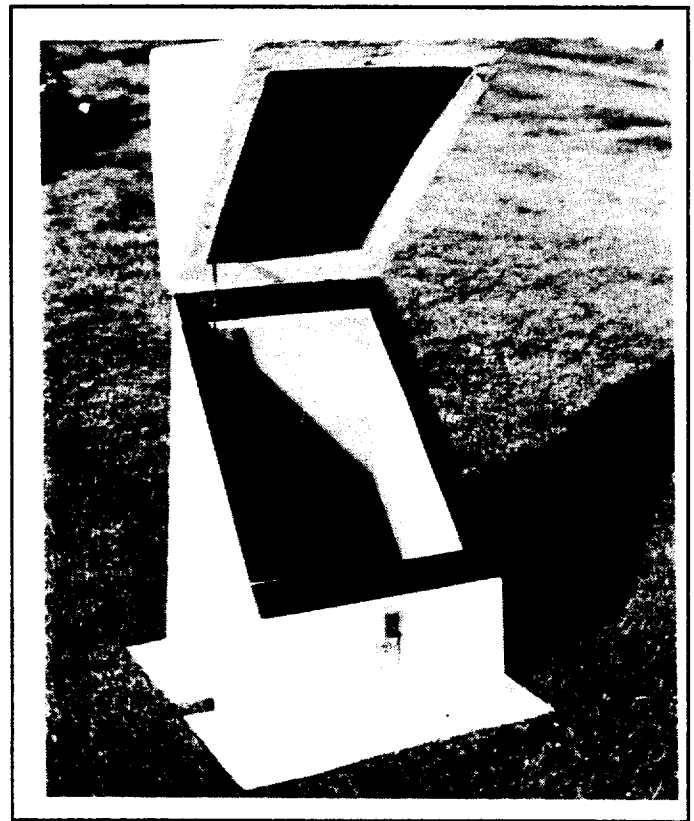


Figure 2-21: Insulated Enclosure.

Services Which May Be Shut Off

Water services which may be shut off for winter, such as irrigation services, pose different kinds of problems for freeze protection. In this case, a properly drained assembly can be left without additional freeze protection. Proper draining of a backflow prevention assembly begins in the installation stage. Some points to be considered are:

- A good quality shutoff valve (resilient seated) should be installed on the upstream side of the assembly below ground level, or inside the building if possible.
- A drain valve should be installed between the shutoff valve and the assembly. If the shutoff valve is installed inside the building, the drain valve can effectively drain all the piping. If the shutoff valve is installed in the ground, a

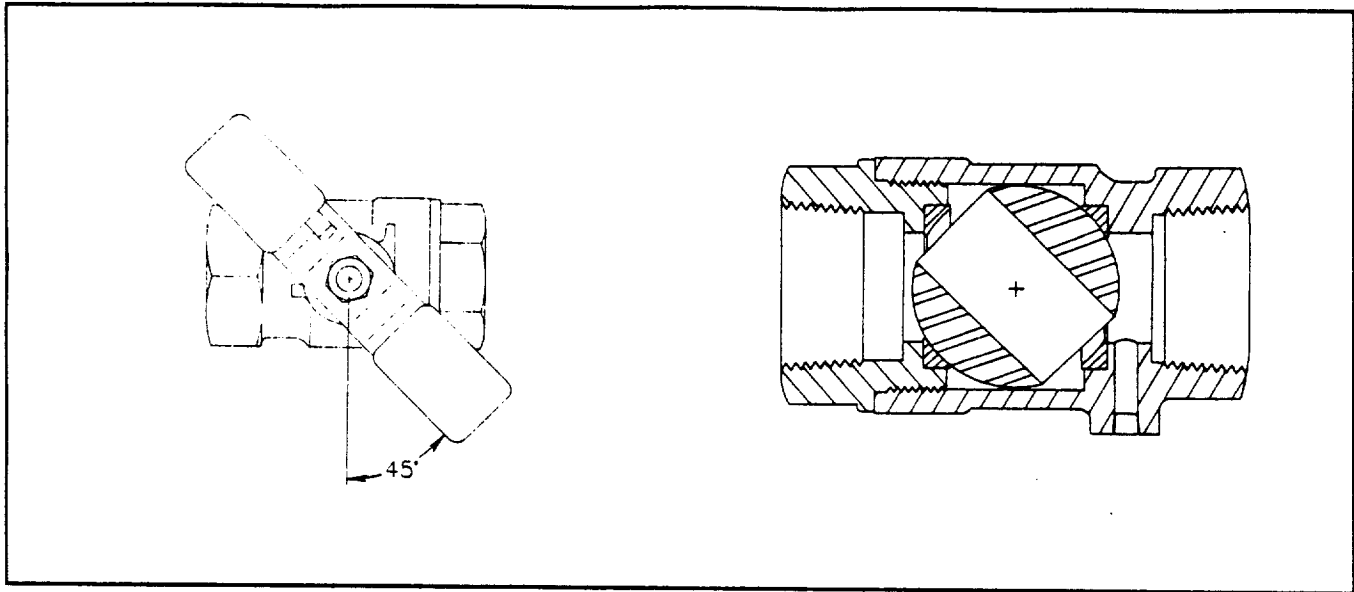


Figure 2-22: View Of Ball Valve In Half Open/Half Closed Position.

drain valve or stop and waste valve below ground level becomes a submerged inlet, which is a cross connection. In this case, the valve must be installed at least 6 inches above ground level.

Provisions must also be made for draining downstream of the backflow prevention assembly. With RPBA's and DCVA's, connections for compressed air can be used along with a low point drain. PVBA's and AVB's, however, can only be drained using a low point drain since they must not be subject to backpressure.

If the local water purveyor allows the use of unions so the assembly can be removed from line during the winter months, annual testing of the assembly must be scheduled in the spring to insure that the assembly is reinstalled and working properly.

Draining Procedure

1. Turn off the main shutoff valve, installed on the inlet side of the assembly.
2. Open all inlet and outlet drain valves, inlet and outlet shutoff valves, and all test cocks.
Important: Leave all ball valves in a half-open position to allow for full

drainage of the valve and to protect the valve from freeze damage (see Figure 2-22).

3. If piping on the downstream side of the assembly will be blown out with compressed air, be sure to open the low point drain on the system and close the outlet shutoff valve on the assembly. **Do not use compressed air to blow out the piping on the inlet side of the assembly.**
4. Connect the compressed air line to the compressed air fitting, and introduce air of sufficient volume to clear the downstream piping. Be sure to open the assembly outlet shutoff valve when completed. Ball valves should be opened to a half open position.
5. To drain the backflow prevention assembly, it may be necessary to loosen the covers on the check and relief valves so entrapped water can drain from the valve cavities. Be sure to re-tighten the covers before placing the assembly back into service.
6. Upon completion, be sure that the main shutoff valve is in the **closed** position to prevent accidental refilling of the system.

Table 2-2: Standards And Testing Laboratories For Backflow Preventer Performance Test And Construction

Product	Current Standards		
	ASSE	AWWA	USCFCCCHR
Atmospheric vacuum breaker	1001		Manual for Cross Connection Control
Hose bibb device	1011		Manual for Cross Connection Control
Dual check with atmospheric vent	1012		
Reduced pressure backflow assembly	1013	C-511-89	Manual for Cross Connection Control
Double check valve assembly	1015	C-510-89	Manual for Cross Connection Control
Pressure vacuum breaker assembly	1020		Manual for Cross Connection Control
Dual check	1024		

References:

ASSE -----American Society of Sanitary Engineering

AWWA -----American Water Works Association

USCFCCCHR -University of Southern California, Foundation for Cross Connection Control and Hydraulic Research

Special Application Devices

This is a brief description of devices available on the market today for specific applications. In some areas, these devices may be considered as a "second line of defense." ***They should never be used in place of an approved reduced pressure backflow assembly, double check valve assembly, or pressure vacuum breaker assembly.*** Since their application is very specific and limited, consult with the local water purveyor prior to installation.

Various standards and listings apply to some of these products (consult the manufacturer's specifications and the partial listing in Table 2-2).

Residential Single Or Dual Check

This unit consists of one or two spring loaded, soft seated, non-testable check valves installed in a single body. It is designed for 3/4 and 1 inch residential service lines (see Figure 2-23).

Dual Check With Atmospheric Vent

This unit is similar in design to the residential dual check. It has the added feature of a vent opening to atmosphere which allows air to enter the unit, or leakage to be vented to atmosphere (see Figure 2-24).

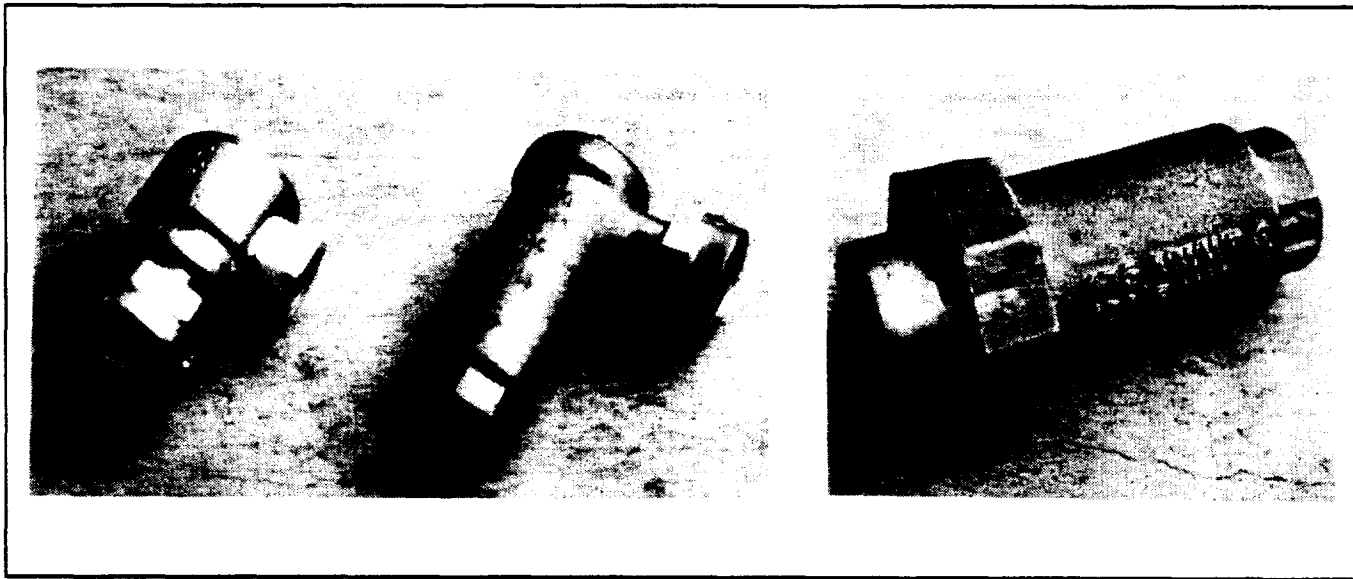


Figure 2-23: Residential Single And Dual Checks.

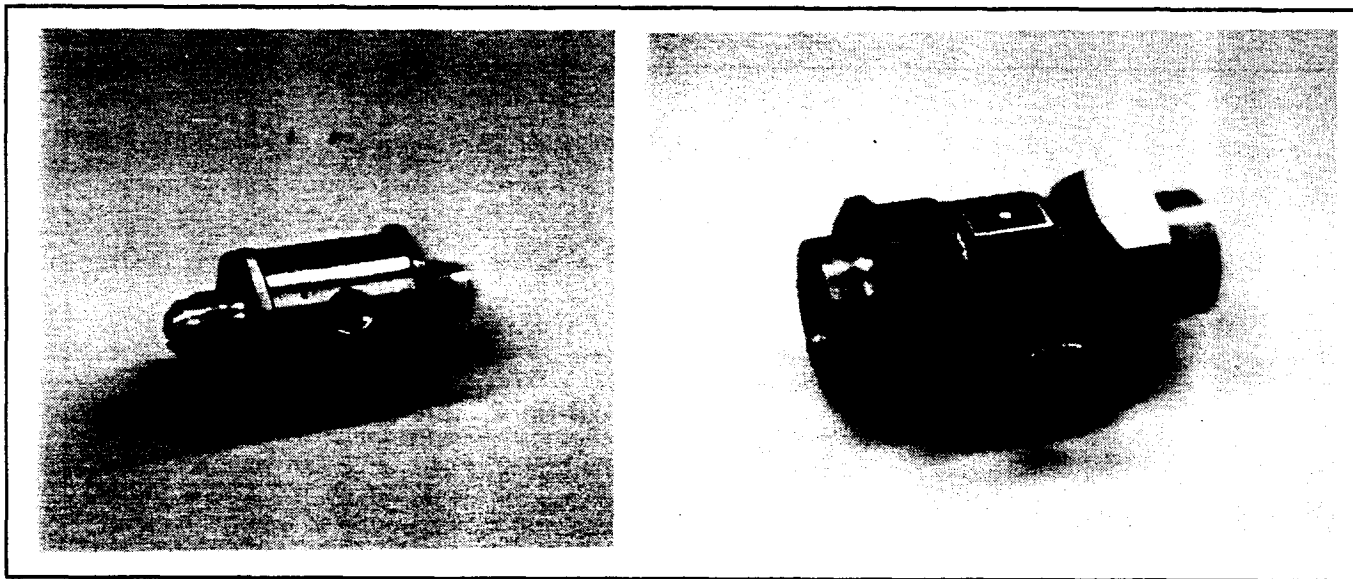


Figure 2-24: Dual Check With Atmospheric Vent.

In-line Faucet And Hose Bibb Devices

These units are used on hose bibb outlets and laboratory fittings where hoses can be attached. They are only designed to prevent backsiphonage. Hose bibb backflow devices can be the adapter

style, which screw onto the hose bibb (Figure 2-25), or the integral type with a hose bibb (Figure 2-26). In all cases, hose bibb backflow devices that are exposed to freezing conditions must have a provision for draining.



Figure 2-25: Adapter Style Hose Bibb Backflow Device.

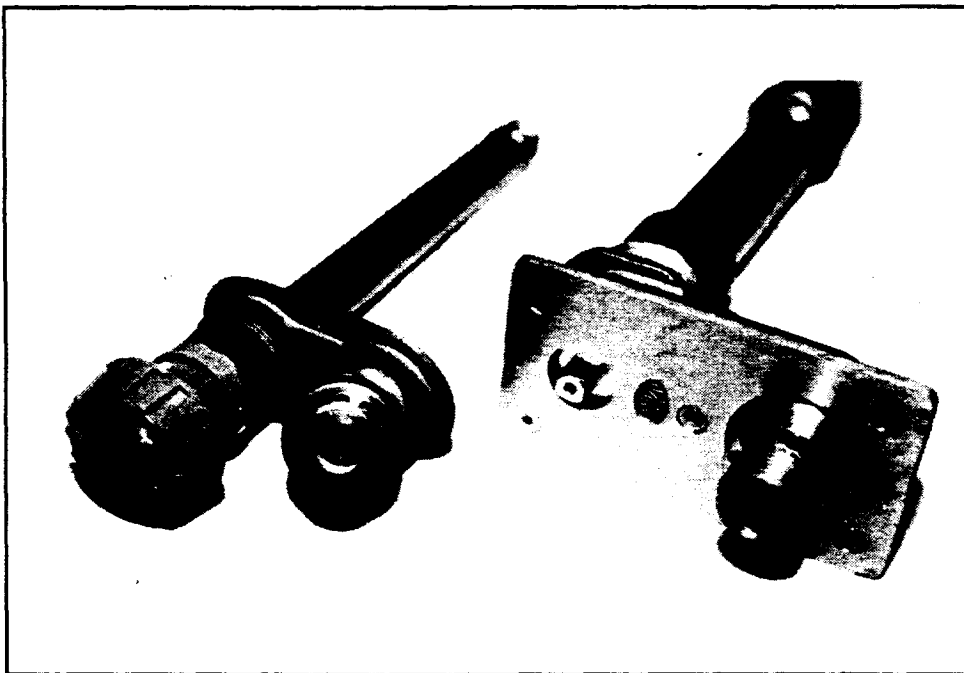


Figure 2-26: Faucets With Integral Backflow Preventer.

Notes:

Section 3

Recommended Backflow Prevention Procedures

Purveyor's Responsibility

Federal, state, and provincial regulations place the responsibility for cross connection control on the water purveyor and/or the local authority. The degree of responsibility varies from state to state and province to province. When implementing a cross connection control program, the water purveyor needs to follow an organized plan that considers these items:

1. To provide local enforcement, an ordinance, code, or resolution shall be enacted to adopt the state or provincial regulations, and outline the purveyor's cross connection program see the Appendix.
2. One person shall be delegated the authority and responsibility to organize and carry out the cross connection control program. That person must be familiar with the causes and hazards of unprotected cross connections. In some cases, small groups of water purveyors may combine their efforts and hire a qualified person to carry out their programs.
3. All existing facilities where cross connections are suspected shall be listed on a priority basis and inspected accordingly.
4. Provisions shall be made to route all applications for new commercial and industrial water services, or for enlarging services, through the person in charge of the cross connection control program.
5. All new commercial and industrial construction shall be inspected for possible cross connections. If possible, plans should be reviewed before construction.
6. A list of backflow prevention assemblies approved for use in the state or province shall be made available to each water user required to provide backflow protection.
7. Adequate records which include the following shall be kept and filed for reference:
 - Date of inspection
 - Results of inspection
 - Recommended protection
 - List of all reduced pressure backflow assemblies (RPBA), reduced pressure detector assemblies (RPDA), double check valve assemblies (DCVA), double check detector assemblies (DCDA), pressure vacuum breaker assemblies (PVBA), and air gaps (AG) used in lieu of an approved backflow prevention assembly in the system
 - Test and maintenance reports
 - All correspondence between the water purveyor, the regulatory and/or local authority and the customer
8. After installation, an assembly shall be inspected, tested, and approved before it is accepted by the water purveyor.
9. Most regulations require testing of backflow prevention assemblies at least once a year. Therefore, the water purveyor shall set up an annual testing program. Normally the water purveyor notifies the customer (owner of the assembly) when the assembly is to be tested. It is then the customer's responsibility to have the assembly tested by a certified tester.
10. A list of certified testers is available from the local authority.

In cooperation with the regulatory and/or local authority, the water purveyor shall make periodic inspections of premises served by the water supply to check for actual or potential cross connections. Any cross connections found in such inspections shall be ordered corrected by the responsible agency. Periodical inspections shall be conducted in accordance with the degree of hazard.

If an immediate hazard to health is caused by the cross connection, water service to the premises must be discontinued until the cross connection has been either protected or eliminated.

Failure of the customer to cooperate in the installation, maintenance, testing, or inspecting of backflow prevention assemblies is grounds for the termination of water service to the premises, or the requirement of an air gap separation. Authority to terminate the water service shall be included in the ordinance, code, or resolution.

The water purveyor must recognize his responsibility to work with other responsible authorities to eliminate or protect cross connections in his system. He must also recognize that he could be held personally liable for any problems that arise due to an unprotected cross connection.

Congress passed the "Safe Drinking Water Act" with the intent of protecting the public health and welfare of all public water supply users in the United States. The Environmental Protection Agency (EPA) interpreted this mandate to mean that certain contaminants should not be found in water "delivered to the free flowing outlet of the ultimate user." Thus, these contaminants became the responsibility of the water purveyor. The EPA specifically exempted contaminants added to the water under circumstances controlled by the user (except for plumbing corrosion by-products). This was not, however, intended to absolve the purveyor of his responsibility to conduct an aggressive cross connection control program.

In applying the recommendations outlined in this section, it is vital that the protection provided be commensurate with the degree of hazard. Where high hazards or unknown hazards exist, a properly maintained air gap separation, or a reduced pressure backflow assembly, shall be used since they offer the highest known degree of protection. Double check valve assemblies or vacuum breakers are used where low hazard (aesthetic problems or undesirable situations) may occur.

Each distribution system has unique problems arising from geographical location, climatic conditions, service demands, and other factors. Each cross connection, therefore, must be examined on an individual basis to determine the necessary type of backflow protection.

Care in selecting an installation site for any backflow prevention assembly is essential to its continued effective operation. These assemblies must not be installed in any enclosure or hooded area containing fumes which are corrosive, toxic, or poisonous. They must have proper drainage when installed indoors. Assemblies must be protected against atmospheric, mechanical, and vehicle abuse. All assemblies shall be installed so they are easily accessible for testing and maintenance. They must not be built into walls or ceilings, or be installed in a manner that could cause personal injury (see Section 2).

Normally, the risk to the water system caused by actual or potential cross connections can be cataloged into one of two categories:

High Hazard: A physical or toxic hazard which could be detrimental to health. High hazard is also referred to as contamination (see Section 8).

Low Hazard: A hazard which could cause aesthetic problems or have a detrimental effect on the quality of water in the system. Low hazard is also referred to as pollution (see Section 8).

To protect in-plant personnel, it is generally preferred to isolate the area of the premises affected rather than to install backflow protection at the meter. However, the history of cross connection control has provided regulatory authorities with sufficient information to establish a list of those premises where hazardous cross connections exist, or where the potential hazard is so great that these premises must be isolated from the utility's system by a positive and reliable means. Some states and provinces have established mandatory protection for these premises. However, it is important that each premise be examined individually to determine the type of backflow protection that will be required.

Never assume that all premises of the same kind will require the same type of backflow protection. The degree of hazard of the actual and potential cross connections must be considered to determine the necessary type of backflow protection. For instance, all clinics may not require an RPBA to adequately protect the public water supply.

Table 3-1 provides a list of abbreviations, arranged by the level of protection they provide. This table has been prepared as a guide to the requirements for protection against cross connections at the meter, or within a premise, to isolate actual or potential cross connection areas.

Premises Isolation

There are premises which will require mandatory premise isolation. Those premises, along with minimum service protection requirements, are noted in Table 3-2 on the following page.

Water purveyors may require backflow protection at the water service to premises other than those listed in Table 3-2 unless it is determined that adequate internal protection is provided. Table 3-3 on the following page lists facilities of this type, along with minimum requirements for backflow protection.

Table 3-1: Abbreviations

Abbreviation	Description	Level of Protection
AG	Air Gap	1
RPBA	Reduced Pressure Backflow Assembly	2
RPDA	Reduced Pressure Detector Assembly	2
DCVA	Double Check Valve Assembly	3
DCDA	Double Check Detector Assembly	3
PVBA	Pressure Vacuum Breaker Assembly	4
AVB	Atmospheric Vacuum Breaker	5

NOTE

Lower numbers in the "Level of Protection" column indicate higher levels of protection.

Table 3-2: Premises Requiring Mandatory Service Protection

Premises	Protection	Premises	Protection
Beverage bottling plants.	RPBA	Nursing homes.	RPBA
Car washes.	RPBA	Petroleum processing or storage plants.	RPBA
Chemical plants.	RPBA	Piers and docks	RPBA
Fire sprinkler services.	DCVA	Radioactive material processing plants or nuclear reactors.	RPBA
Food processing plants.	DCVA	Sewage lift stations.	RPBA
Hospitals, medical centers, and clinics.	RPBA	Sewage pump stations.	RPBA
Inspection restricted.	RPBA	Sewage treatment plants.	RPBA
Laboratories.	RPBA	Tall buildings (over 30 feet, domestic water).	DCVA
Metal plating industries.	RPBA	Unapproved auxiliary supply.	RPBA
Mortuaries.	RPBA		

Table 3-3: Facilities Requiring Backflow Protection

Facilities	Protection	Facilities	Protection
Battery manufacturing or repair facilities.	RPBA	Graving docks.	RPBA
Boat marinas.	RPBA	Ice manufacturing plants.	RPBA
Canneries.	DCVA	Mobile home parks.	DCVA
Cold storage plants.	RPBA	Packing houses (Slaughter houses).	RPBA
Commercial laundries.	RPBA	Paper product plants.	RPBA
Concrete mixing plants.	DCVA	Parks and playgrounds.	DCVA
Dairies.	DCVA	Plasma centers.	RPBA
Dry cleaners.	RPBA	Sand and gravel plants.	DCVA
Dry docks.	RPBA	Ship repair facilities.	RPBA
Farms.	DCVA	Shopping centers.	DCVA
Film processing facilities.	RPBA		

In-plant Isolation

In addition to the mandatory premise isolation previously discussed, there are a number of fixtures, equipment, or areas common to many customer's premises which are actual or potential cross connections. These fixtures, equipment, or areas must be regularly inspected and analyzed to determine their potential risk to the system.

They must be provided with proper backflow protection either at the fixture, equipment, or area. Table 3-4 lists several examples and the minimum protection requirements.

Table 3-4: Fixtures, Equipment, and Areas Requiring Backflow Protection

Fixtures, Equipment, and Areas	Protection	Fixtures, Equipment, and Areas	Protection
Air compressors.	DCVA	Computer cooling lines.	AG/RPBA
Air conditioning systems.	RPBA	Condensate tanks.	AG/RPBA
Air washers.	RPBA	Cooking kettles.	AG/AVB
Aquarium make-up water.	AG/RPBA	Cooling towers.	AG/RPBA
Aspirators, medical.	AVB	Decorative ponds.	AG/RPBA
Aspirators, weedicide, herbicide and pesticide.	AVB	Degreasing equipment.	RPBA
Autoclaves.	RPBA	Demineralized water systems.	RPBA
Autopsy tables.	RPBA	Dental cuspidors.	RPBA
Baptismal founts.	AG/AVB	Detergent dispensers (dishwasher).	AVB
Bathtub, below rim filler.	Not Allowed	Dialysis equipment.	RPBA
Bedpan washers.	AVB	Dishwashers.	AVB
Beverage dispensers using CO ₂ .	RPBA	Drinking fountains.	AG
Bidets.	AVB	Dye vats and tanks.	AG/RPBA
Boat lifts.	RPBA	Dynamometers.	DCVA
Boiler feed lines.	AG/RPBA	Emergency generators.	RPBA
Bottle washing equipment.	RPBA	Etching tanks.	AG/RPBA
Box hydrants.	PVBA/DCVA	Fermenting tanks.	AG/RPBA
Brine tanks.	AG/DCVA	Fertilizer injection equipment.	RPBA
Can washing equipment.	AVB/PVBA	Film processors.	RPBA
Chemical feeder tanks.	AG/RPBA	Fire department connections.	DCVA
Chilled water systems.	RPBA	Fire sprinkler systems (see Section 4).	DCVA
Chlorinators.	RPBA	Floor drains.	AG
Coffee urns.	AG/AVB	Flushing floor drains.	AVB

Table 3-4 Continued

Fixtures, Equipment, and Areas	Protection	Fixtures, Equipment, and Areas	Protection
Foamite systems.	RPBA	Outboard motor test tanks.	AG/AVB
Fountains, ornamental.	AG/RPBA	Perchlorethylene reclaim machines.	RPBA
Fume hoods.	AVB	Pesticide applicator trucks.	AG/RPBA
Garbage can washers.	AVB/PVBA	Photo developing tanks and sinks.	RPBA
Garbage disposals.	AVB	Photostat equipment.	RPBA
Heat exchangers.	see Section 4	Pipette washers.	AVB
Heat pumps.	RPBA	Potato peelers.	AVB
High pressure washers.	DCVA	Poultry feeders.	RPBA
Hose bibbs.	AVB	Private hydrants.	DCVA
Hoses, kitchen rinse.	AVB	Processing tanks.	AG/RPBA
Hot tubs.	AG/RPBA	Pump seal water.	AG
Hot water heating systems.	RPBA	Pumps, pneumatic ejector.	RPBA
Hot water boilers.	RPBA	Pump prime lines.	DCVA
Humidifier tanks and boxes.	AG	Pumps, water operated ejector.	RPBA
Hydraulically operated equipment.	DCVA	Radiator flushing equipment.	RPBA
Hydrotherapy baths.	AVB	Recreational vehicle dump stations.	RPBA
Ice makers.	AG	Serrated faucets.	AVB
Industrial fluid systems.	RPBA	Service sinks.	AVB
Intertied (looped) water systems.	DCVA	Sewer connected equipment.	AG
Irrigation systems.	see Section 4	Sewer flushing.	AG
Janitor sinks.	AVB	Shampoo basins/hose rinse.	AVB
Kitchen equipment.	AVB	Showers, telephone.	AVB
Laboratory equipment.	RPBA	Sitz baths.	AVB
Laundry machines, commercial.	RPBA	Soap mixing tanks.	AG/AVB
Lavatories.	AVB	Solar heating systems.	see Section 4
Lawn sprinkler systems.	see Section 4	Solution tanks.	AG/RPBA
Livestock drinking tanks.	AG/AVB	Spas.	AG/RPBA
Make-up tanks.	AG/RPBA	Specimen tanks.	AG/RPBA
Mobile carpet cleaners.	RPBA	Starch tanks.	AG/DCVA
Mop sinks.	AVB	Steam-air sprays.	RPBA

Table 3-4 Continued

Fixtures, Equipment, and Areas	Protection	Fixtures, Equipment, and Areas	Protection
Steam cleaners.	RPBA	Wash-up sinks.	AG/AVB
Steam ejectors.	RPBA	Wash tanks.	AG/AVB
Steam generating facilities.	RPBA	Waste water lines.	AG
Sterilizers.	RPBA	Water-air sprays.	DCVA
Still.	RPBA	Water closets.	AVB
Sumps.	AG	Water cooled equipment.	DCVA
Swimming pools.	AG/RPBA	Water ejectors.	RPBA
Toilets.	AVB	Water recirculating systems.	DCVA
Trap primers.	AG	Water settling.	DCVA
Ultrasonic baths.	AG	Water treatment tanks.	AG/RPBA
Urinals.	AVB	Water trucks.	DCVA
Used water systems.	RPBA	Wet vacuum systems.	RPBA
Vats.	AG/AVB	Whirlpool baths.	AVB
Wading pools.	AG/RPBA	Windshield washer fluid aspirators.	RPBA
Wall hydrants.	AVB	X-ray processors.	RPBA
Wash basins.	AG/AVB		

Notes: _____

Section 4

Recommended Installation Practice

Premise Isolation

The practice of premise isolation is used to protect against cross connections on premises where actual or potential hazards exist. Under this philosophy, the entire premise is separated from the utility's system by means of a backflow prevention assembly installed at or near the service connection. In many industrial complexes, or where access is restricted, premise isolation is the only method of system protection available to the water purveyor. However, premise isolation does not offer any protection to personnel or customers within the premise.(see Figures 4-1 and 4-2).

In-plant Isolation

In-plant isolation is the practice of installing backflow prevention assemblies to protect one or more cross connections within a consumer's facility. This type of protection is necessary to protect in-plant personnel and customers. The backflow prevention assemblies may be sized smaller because of smaller piping, and less-expensive backflow preventers may be used to isolate each specific hazard (see Figures 4-3 and 4-4). However, extreme health hazards or water purveyor policies may also require premise isolation.

Extreme Health Hazard

Some facilities have intricate plumbing and processes which present an extreme hazard to both the potable supply and the consumer's water system. In these situations, in-plant and premise isolation shall be utilized. Because of the extreme

health hazard involved between the potable water supply and the process water used within the facility, an approved air gap shall be installed. Some examples of these facilities are listed below:

- Wastewater Treatment Plants
- Radioactive Material Processing Plants
- Nuclear Reactors

For example, wastewater treatment plants shall have a reduced pressure backflow assembly installed on the service line to the plant, and an air gap on any water line that supplies water for use in the treatment process area. This includes seal water, plant wash down water, flushing lines, etc. (see Figure 4-6). This process water is usually connected directly to sewage, or could come in contact with it. Chapter 10 of the Uniform Plumbing Code states, "Direct connections between potable water piping and sewer connected wastes shall not exist under any condition with or without backflow protection."

In addition, Chapter 10, of the Uniform Plumbing Code states that water downstream of the air gap shall be considered non-potable, and shall be labeled every 3 to 5 feet "**Danger-Unsafe Water.**" Figures 4-5 and 4-6 show methods of protecting these plants. All exposed piping, including hose bibbs, that is down stream from any approved backflow prevention assembly is considered to be non-potable water piping and should be labeled as such. An exception to this rule is only possible if the water purveyor elects to require protection on their potable water distribution system, (premise isolation), and the following conditions exist:

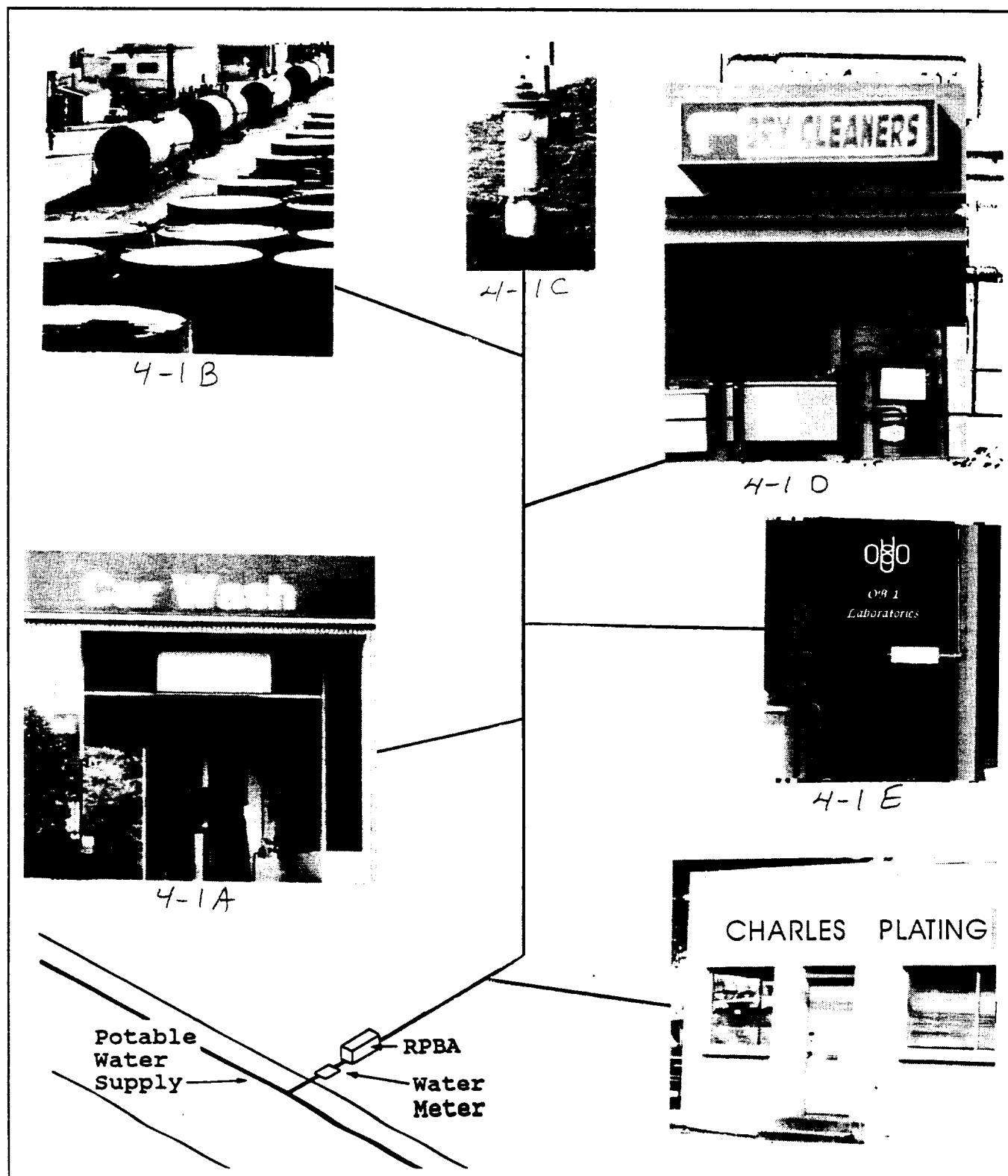


Figure 4-1: Example Of Premise Isolation.

* Approved backflow protection required. This protects the distribution system from hazards which may backflow from in-plant.

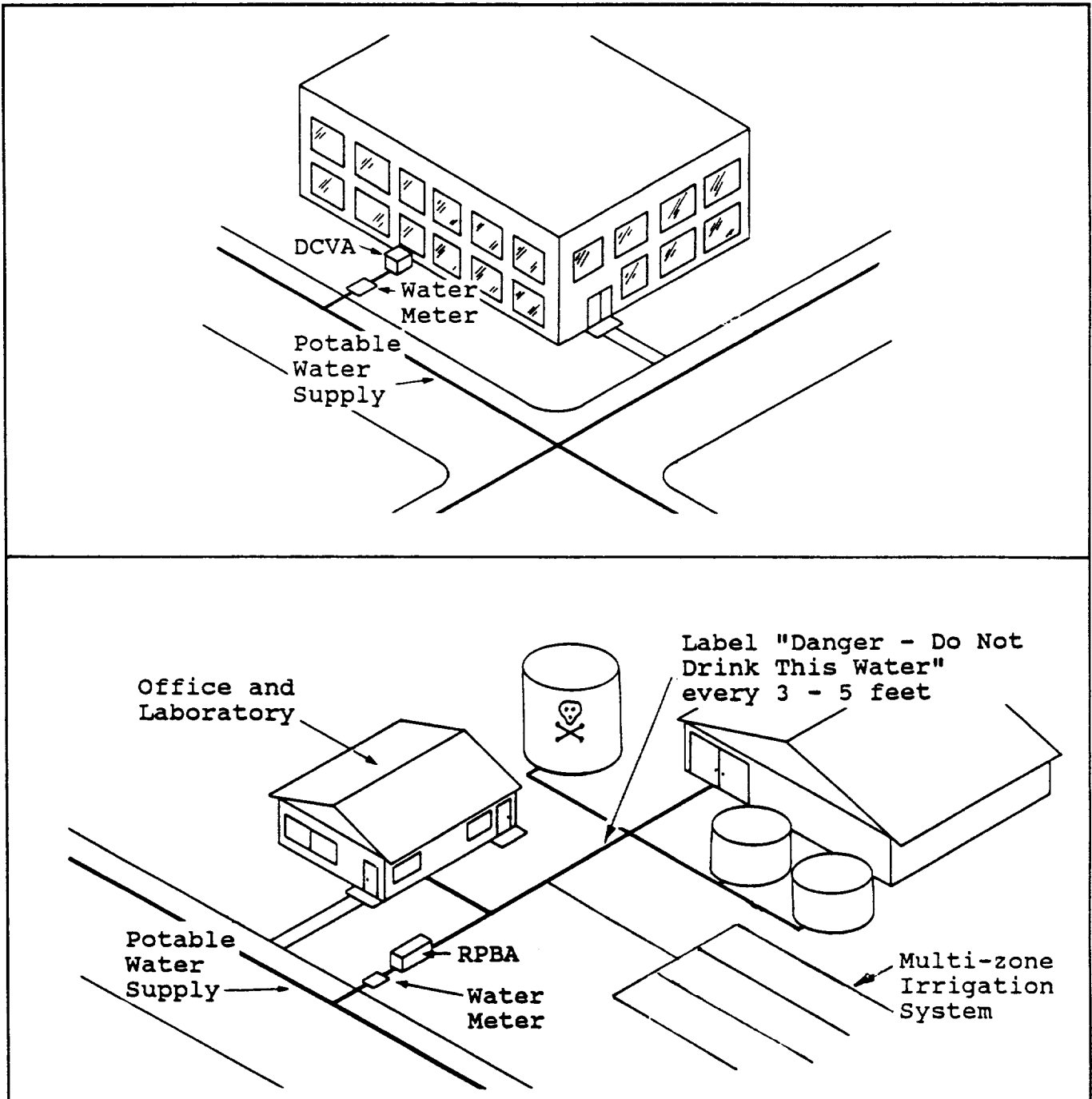
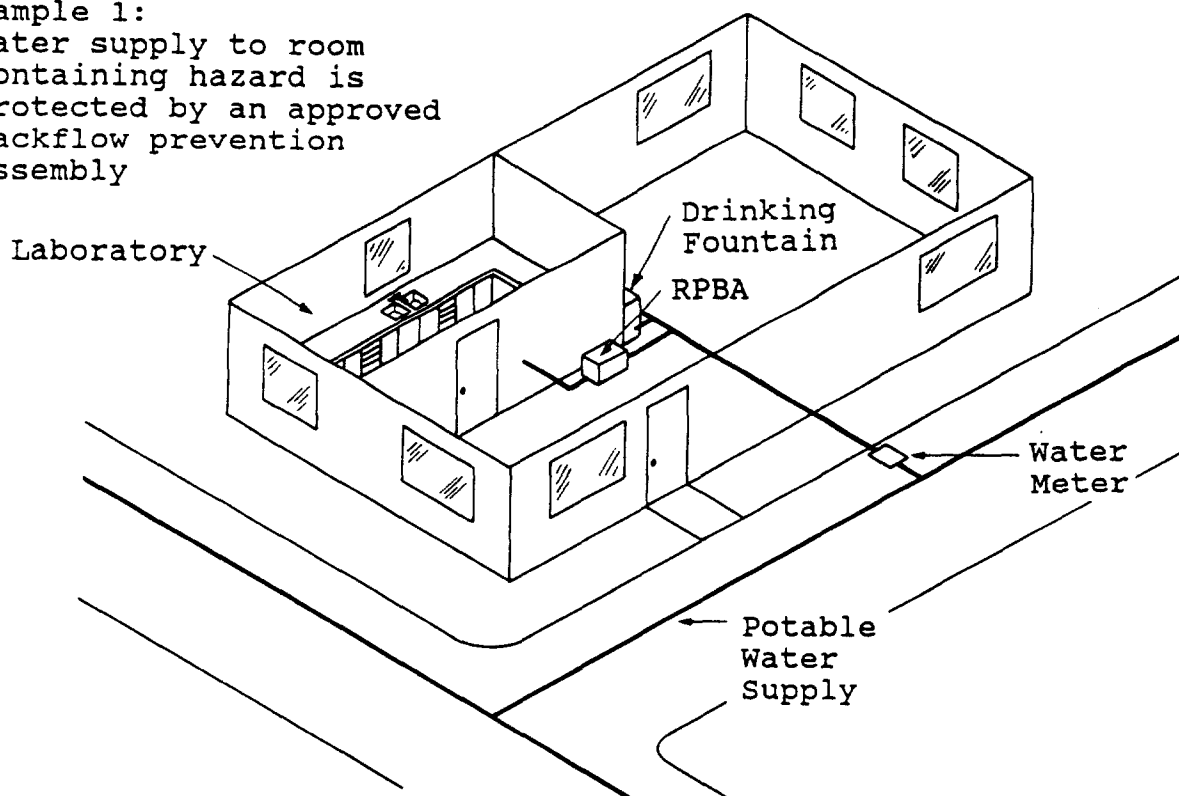


Figure 4-2: Another Example Of Premise Isolation.

NOTE

Consult your local water purveyor prior to installation of backflow preventers.

Example 1:
Water supply to room
containing hazard is
protected by an approved
backflow prevention
assembly



EXAMPLE 2:
Water supply to process
area is isolated from
remainder of premises

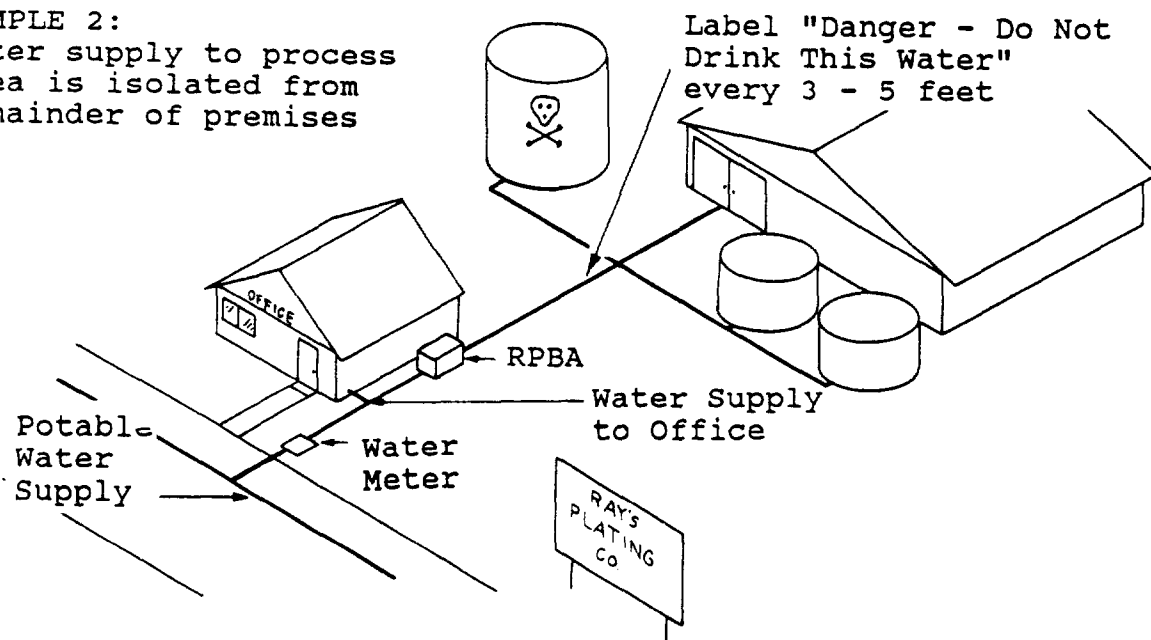


Figure 4-3: Examples Of In-plant Isolation.

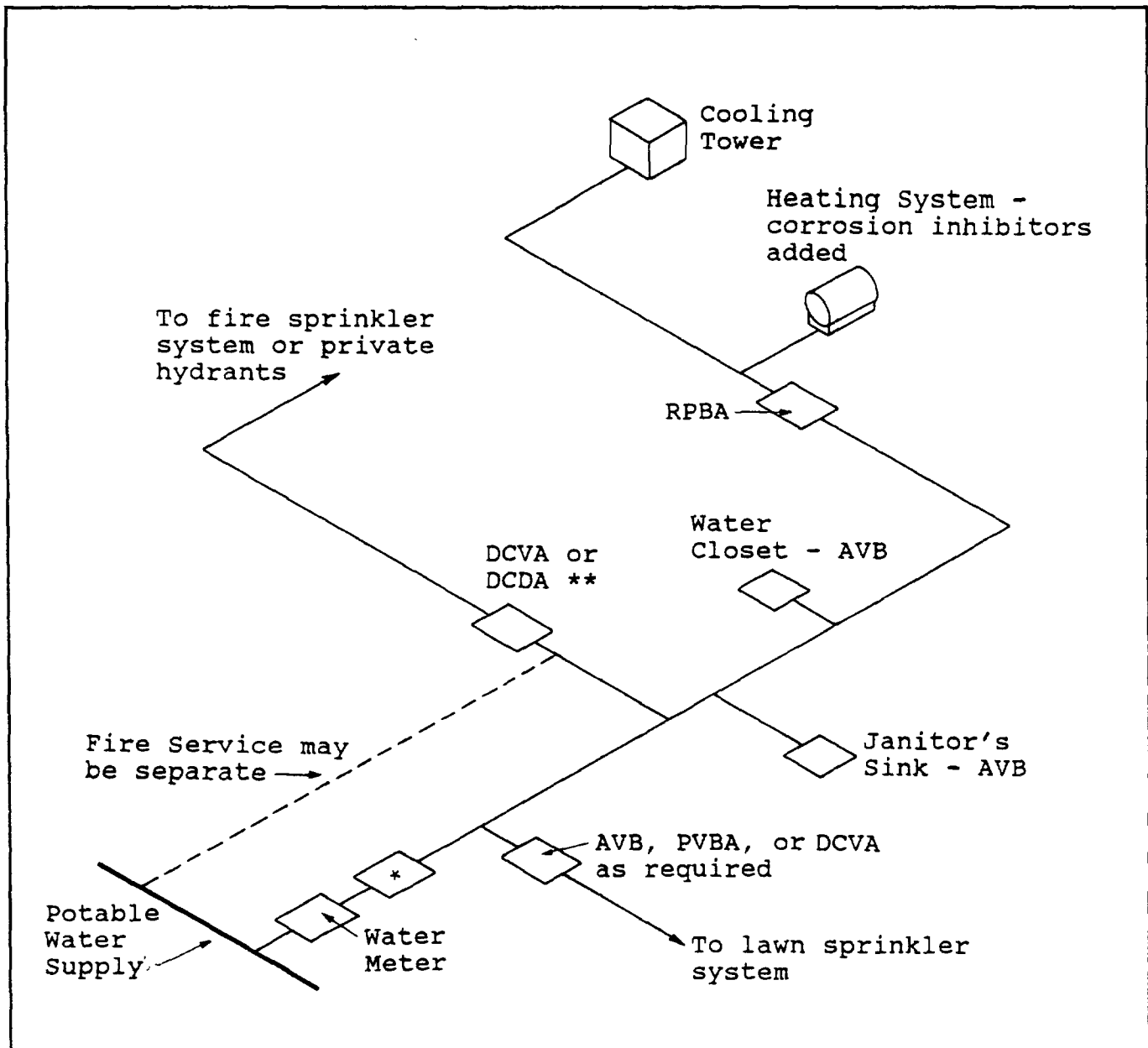


Figure 4-4: Another Example Of In-plant Isolation.

* Additional backflow protection may be required on the service line.

** The choice of assemblies for in-plant protection is dependent upon the degree of hazard and the installation requirements for each assembly.

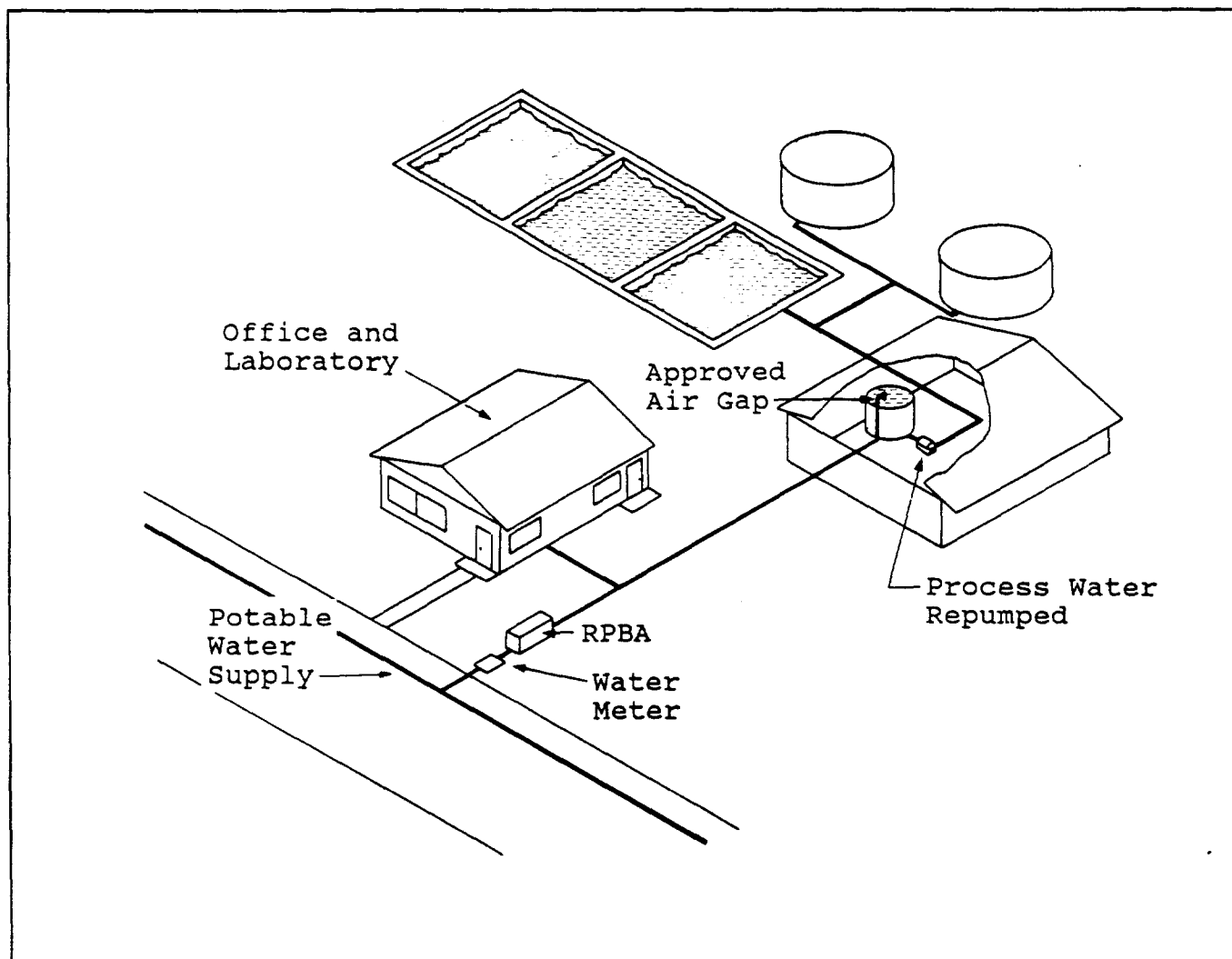


Figure 4-5: System Protection Against Extreme Health Hazard.

* An extreme health hazard shall have in-plant protection with an approved air gap and a reduced pressure backflow assembly at the service line.

Installations Requiring Continuous Service

- The piping system is designed to provide only potable water.
- The piping system is upstream of (before) all in-plant isolation.

The choice of assemblies for premise isolation and in-plant protection is dependent upon the degree of hazard as discussed in Section 3.

If a customer requires continuous, uninterrupted service, provisions shall be made for the parallel installation of two backflow prevention assemblies of the same type. The two assemblies shall have a combined capacity to maintain the flow rate of the single service pipe as established by the AWWA specification for that size of pipe. Two separate services, with a single assembly on each, may also be installed. Service to hospitals is one example where this type of installation is required (see Figure 4-7).

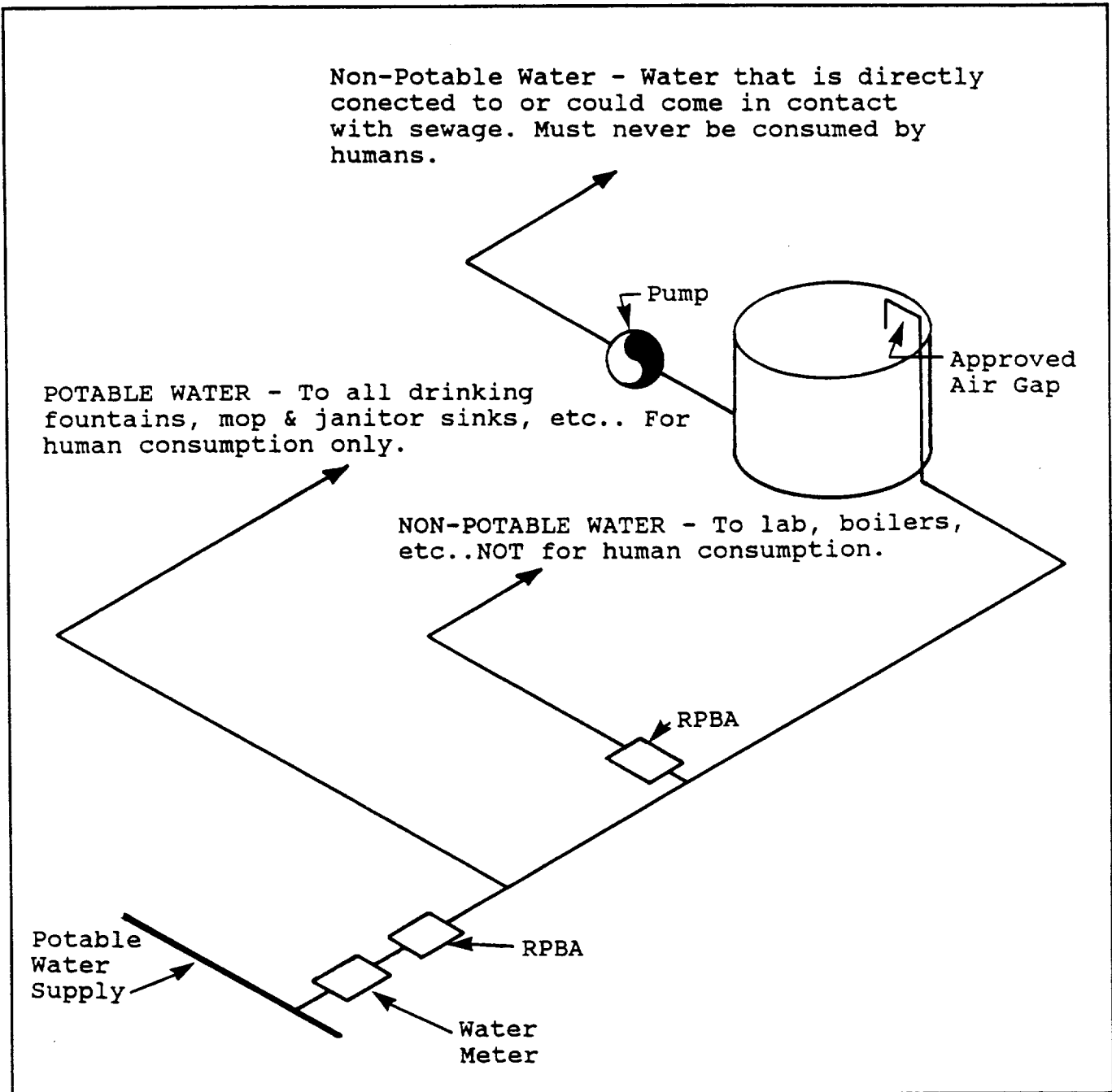


Figure 4-6: Example Of Backflow Protection For Wastewater Treatment Plant.

- * All exposed non-potable and process water piping including hose bibbs, shall be labeled every 3 to 5 feet - **"DANGER - UNSAFE WATER."**

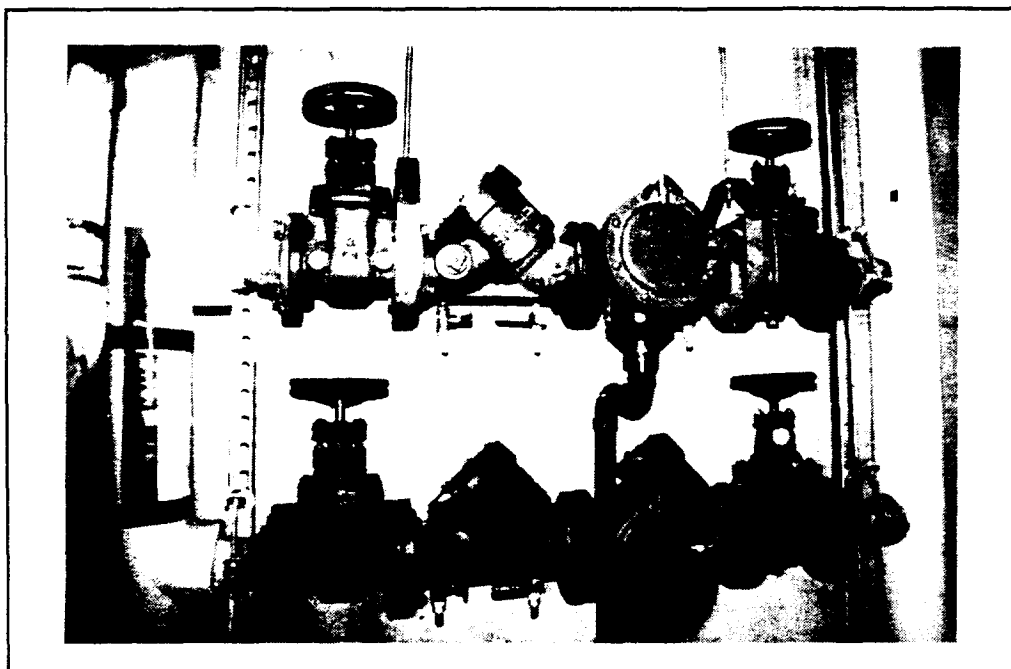


Figure 4-7: Installation Required For Continuous Service.

Note

1. *Provide adequate space between assemblies to allow removal of the check valves and the relief valve on an RPBA.*
2. *When installed in unheated areas, provide freeze protection.*
3. *Assemblies may be installed side-by-side, but adequate space must be maintained for testing and maintenance.*

Irrigation Systems

All irrigation systems must have approved backflow protection that is commensurate with the degree of hazard. Irrigation systems are categorized as high-hazard or low-hazard as defined below. All irrigation piping downstream of an approved backflow prevention assembly shall be classified as a non-potable water system due to an actual or potential health hazard.

High-Hazard: An approved reduced pressure backflow assembly, or an approved air gap separation, shall be required in all cases where chemicals or herbicides are injected into the irrigation system.

Low-Hazard: An approved double check valve

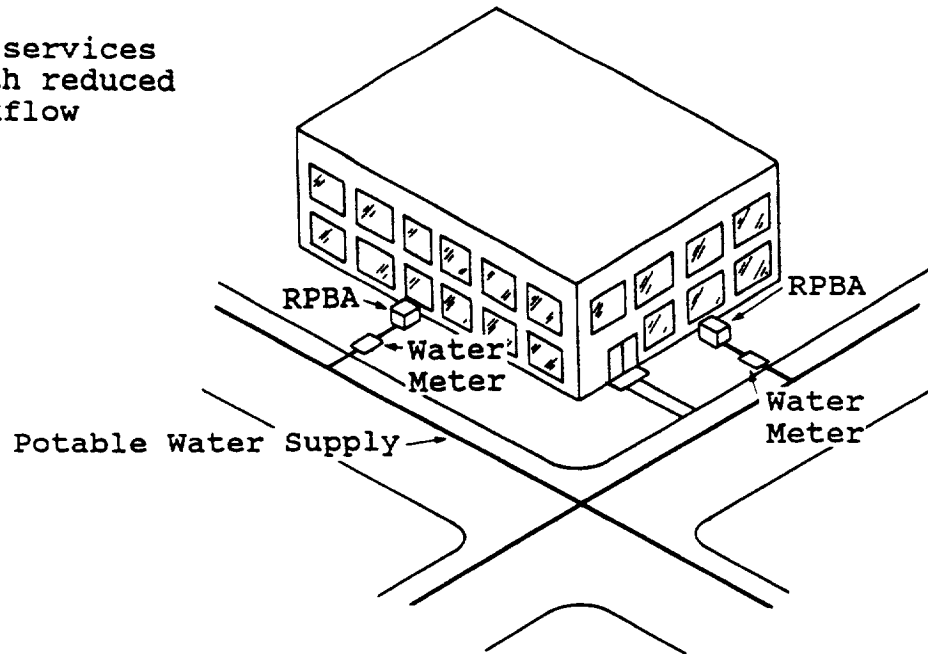
assembly, pressure vacuum breaker assembly, or atmospheric vacuum breaker will be required in all cases not determined to be a high-health hazard.

Atmospheric and pressure vacuum breakers, when properly installed, can be used as backflow protection on irrigation systems (see Section 2 for minimum installation standards). However, these backflow preventers do not provide adequate protection if they are subject to flooding, backpressure, elevated piping, or if compressed air* is used to winterize the irrigation systems. In these situations, an approved double check valve assembly shall be required as a minimum level of protection.

* The compressed air adaptor must be installed downstream of the DCVA or RPBA.

EXAMPLE 1:

Two separate services
protected with reduced
pressure backflow
assemblies



EXAMPLE 2:

One service protected
with parallel reduced
pressure backflow
assemblies

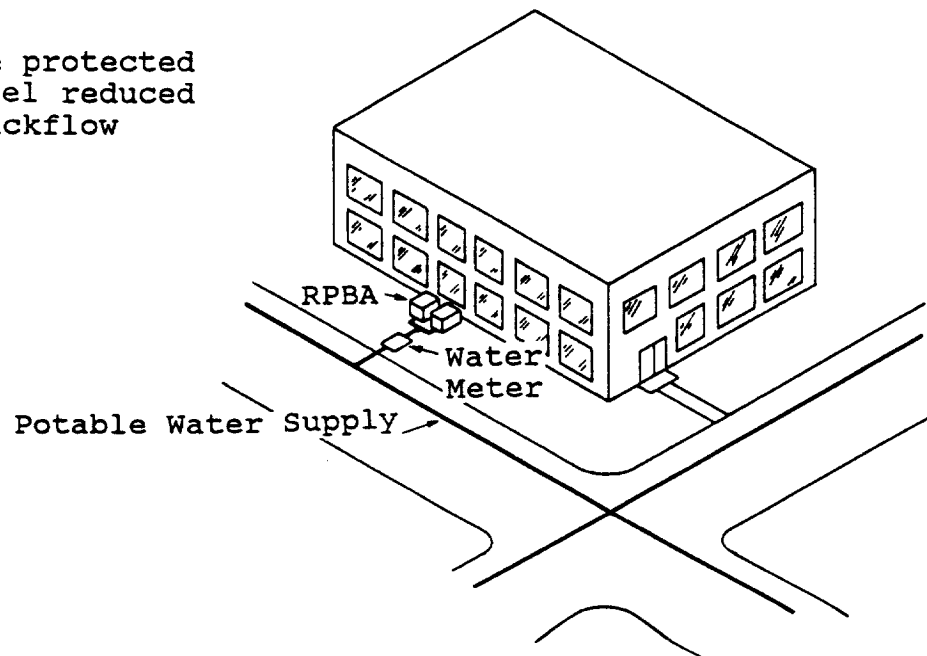


Figure 4-8: Uninterruptible Service To Hazardous Facility.

NOTE

Reduced pressure backflow assemblies may be installed inside building. Adequate drainage must be provided.

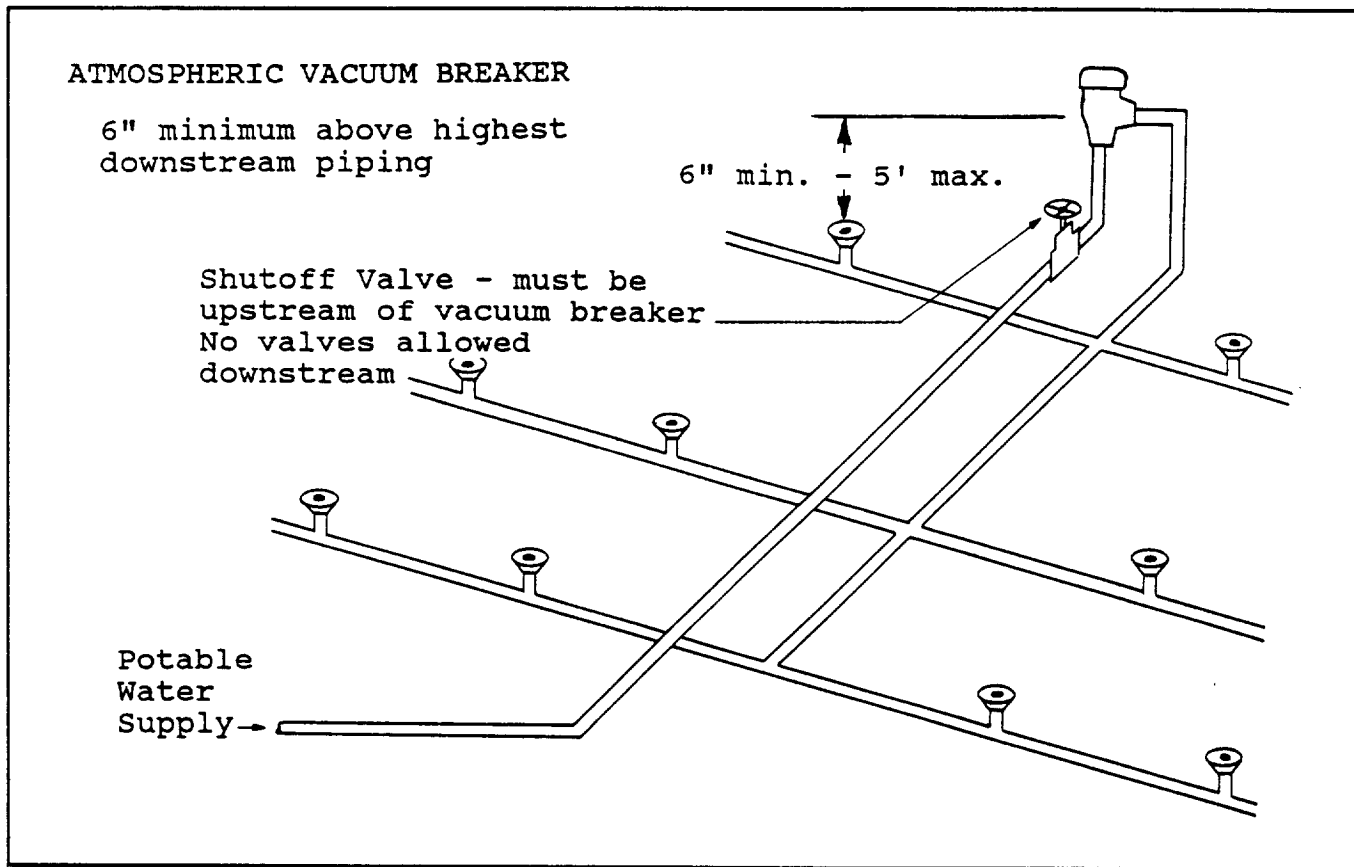


Figure 4-9: Hillside Irrigation System Using Atmospheric Vacuum Breaker.

Hillside Irrigation Systems With Water Service At Bottom

- **Atmospheric Vacuum Breaker:** Control valves are not allowed downstream from the vacuum breaker (see Figure 4-9).
- **Pressure Vacuum Breaker Assembly:** Control valves are allowed anywhere in the piping system (see Figure 4-10).
- **Double Check Valve Assembly:** Control valves are allowed anywhere in the piping system (see Figure 4-11).
- **Reduced Pressure Backflow Assembly:** Control valves are allowed anywhere in the piping system. This backflow preventer is required for use on chemical injection systems (see Figure 4-12).

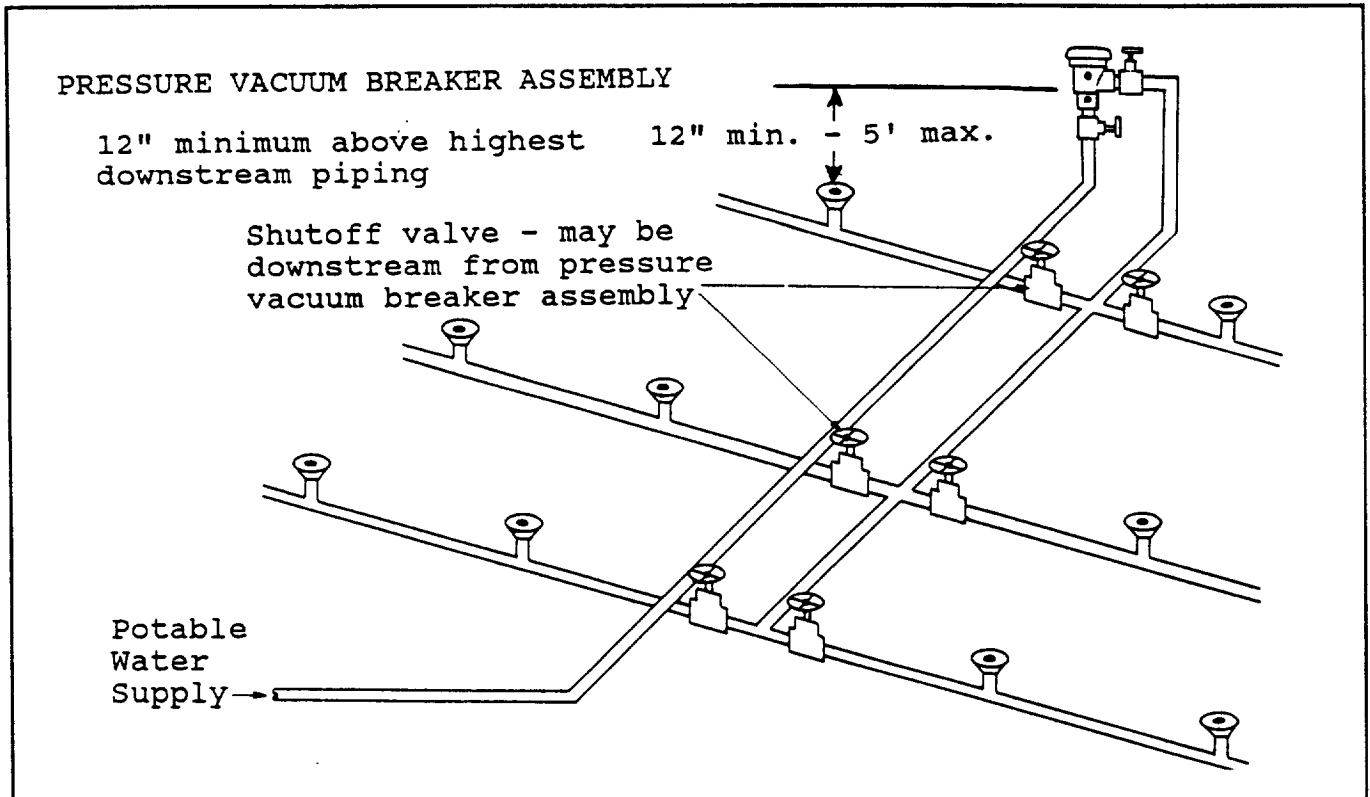


Figure 4-10: Hillside Irrigation System Using Pressure Vacuum Breaker Assembly.

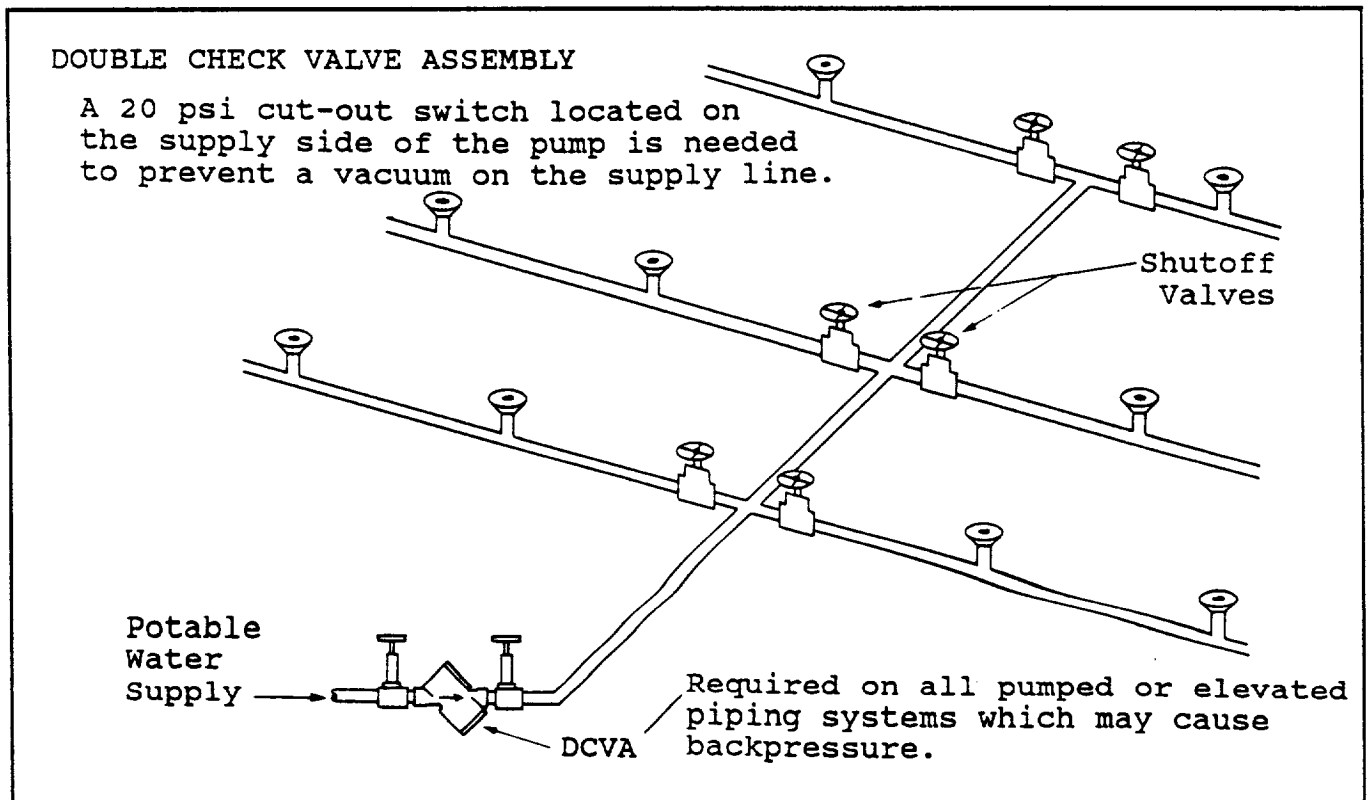


Figure 4-11: Hillside Irrigation System Using Double Check Valve Assembly.

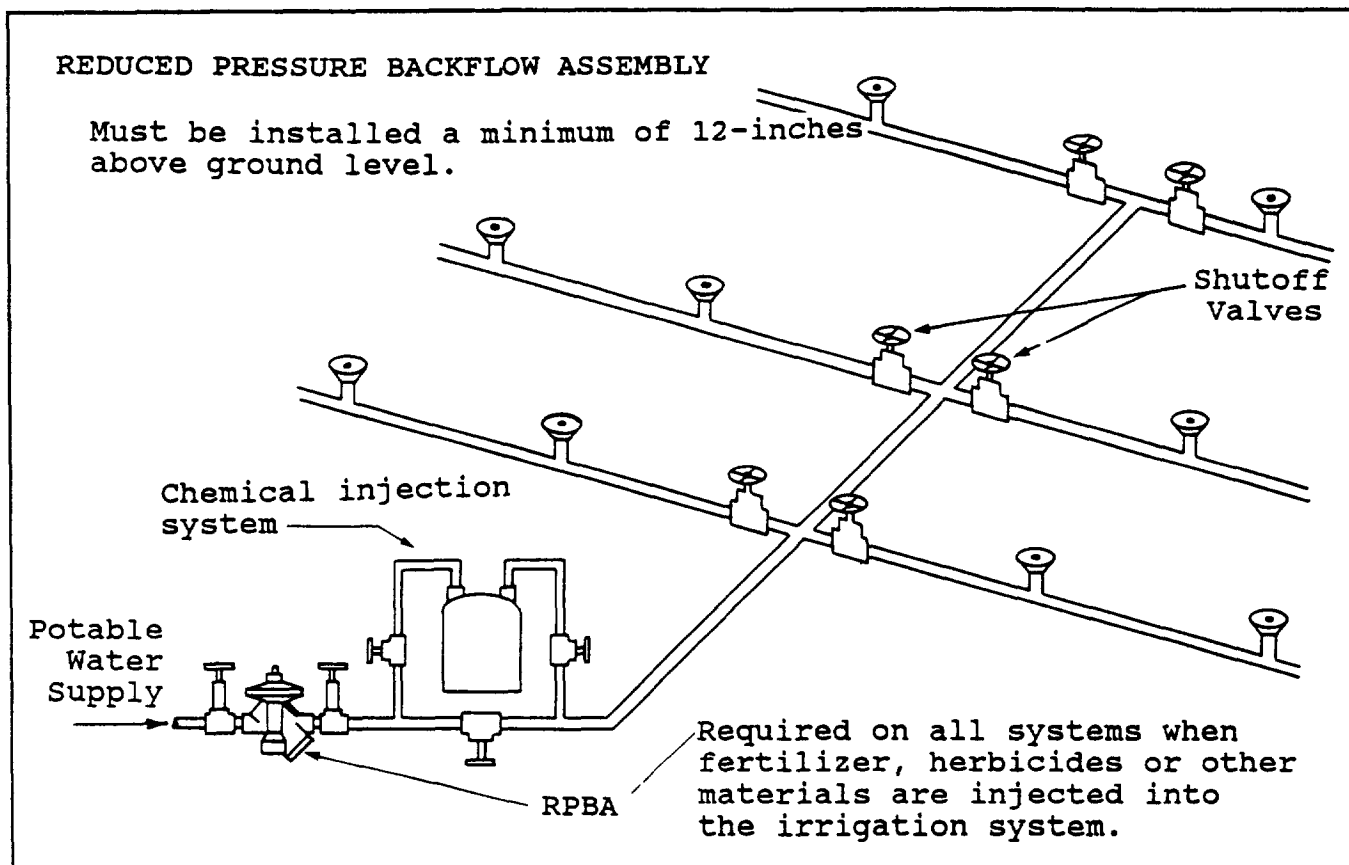


Figure 4-12: Hillside Irrigation System Using Reduced Pressure Backflow Assembly.

Level Terrain - Multi-zone Irrigation Systems

- **Atmospheric Vacuum Breaker:** Control valves are not allowed downstream from the vacuum breaker (see Figure 4-13).
- **Pressure Vacuum Breaker Assembly:** Control valves are allowed anywhere in the piping system (see Figure 4-14).
- **DCVA or RPBA:** May also be installed on these systems in lieu of PVBA or AVB.

Drip Irrigation Systems

- **AVB or PVBA:** Shall be used on systems that are not subject to backpressure.
- **DCVA:** Shall be used on systems which are subject to backpressure.
- **RPBA:** Shall be used on systems that use a chemical injection system.

Testing of AVBs is not required, although inspections have indicated a high rate of improperly installed AVBs. They are frequently installed with valves downstream and/or lower than the 6" minimum height requirement. Compressed air adapters may only be installed downstream of the RPBA or DCVA, and shall never be used on systems that use AVBs or PVBAs for backflow protection.

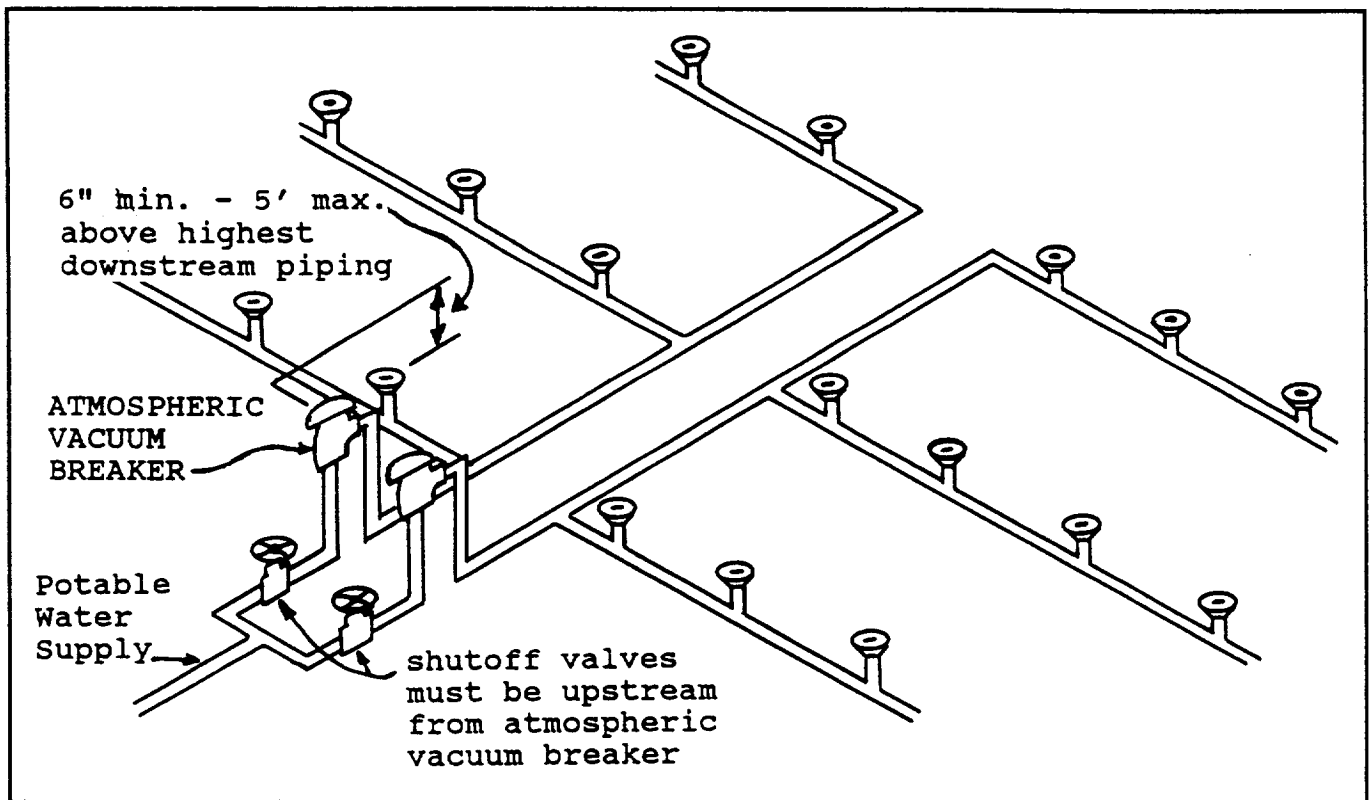


Figure 4-13: Level Terrain - Multi-zone Irrigation System Using Atmospheric Vacuum Breaker.

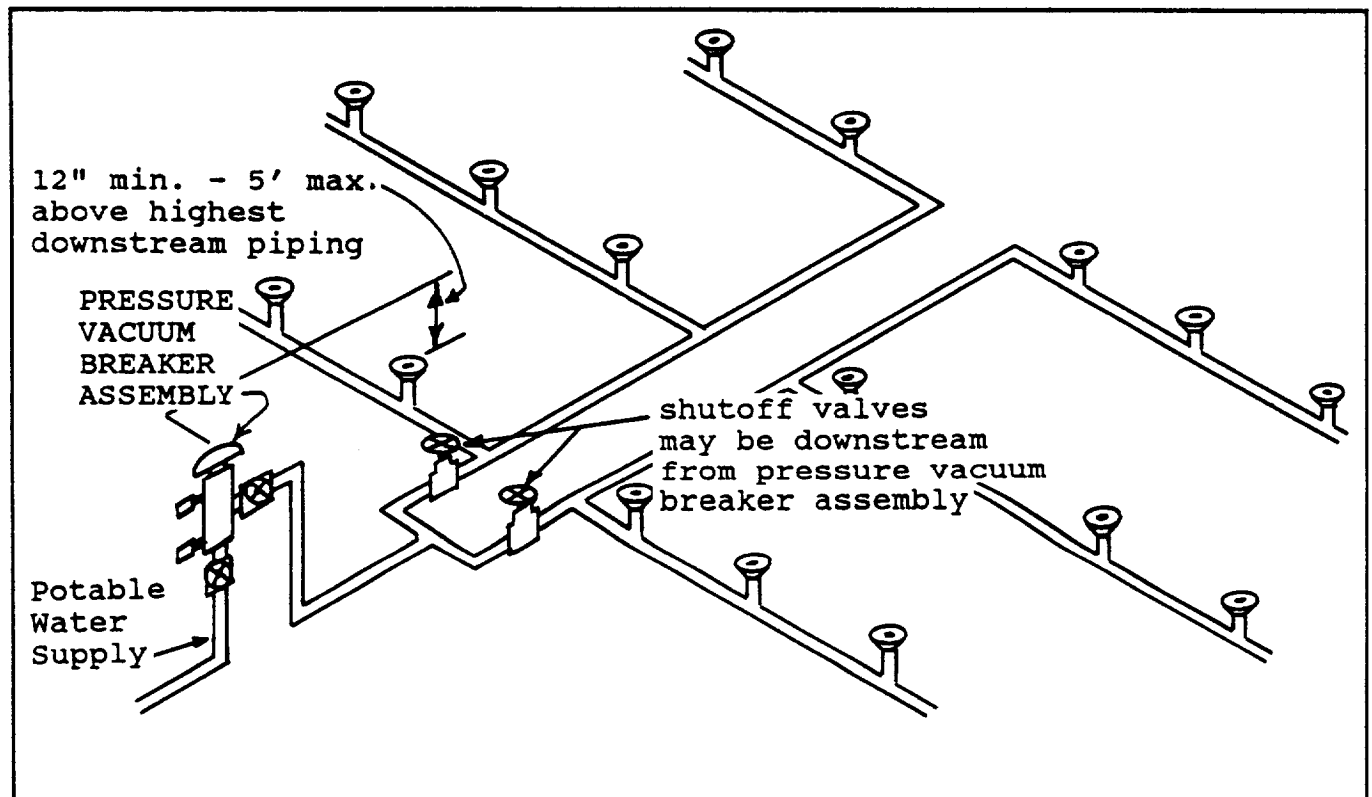


Figure 4-14: Level Terrain - Multi-zone Irrigation System Using Pressure Vacuum Breaker Assembly.

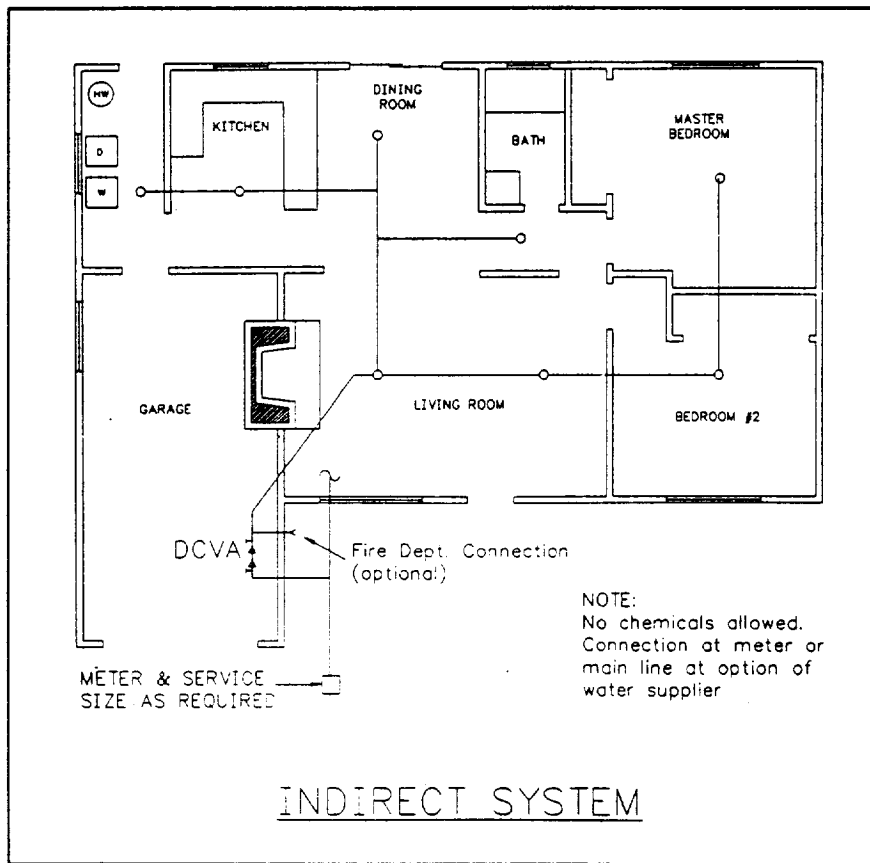


Figure 4-15: Residential Fire Sprinkler System

Private Fire Protection Systems Connected To Potable Water Systems

Fire protection systems must be considered as non-potable systems due to the quality of water found in them. Listed below are several concerns the water purveyor will have with these systems. These concerns require that each system be evaluated by the water purveyor to determine its degree of hazard.

- The growth of offensive microorganisms which can create taste and odor problems.
- The leaching of metals such as zinc, cadmium, iron, copper, or lead into the water.

- The addition of corrosion inhibitors, antifreeze, or other chemicals to protect the piping systems.
- Dry systems containing compressed air or nitrogen.
- Systems which are constructed of unapproved or non-potable water piping or materials.
- A loss of pressure on the potable water supply main, or an increase in pressure on the consumer's system, which allows water from these systems to enter the potable supply.

If backflow from these systems should occur, the hazards will vary from a low hazard to a high hazard. For this reason, it is required that all fire systems which are connected to

a potable water system, either directly or indirectly on the property side of a potable water service, shall be protected with an approved backflow prevention assembly. The level of backflow protection shall be commensurate with the degree of hazard.

The purveyor may require a detector meter on the system to detect any unauthorized use or leakage within the system. This is usually accomplished using a single detector check, double check detector assembly, or reduced pressure detector assembly, depending on the degree of hazard determined by the purveyor. **A single detector check or single check valve shall not be considered an approved backflow preventer.** Most fire protection systems will have a fire department pumper connection. In these cases, the pumper connection **must** be installed downstream of the backflow prevention assembly.

Following are descriptions of those situations which determine the different fire system hazards, and the minimum type of backflow protection recommended for each:

High-Hazard Fire System

- All foamite systems.
- Systems where an unapproved auxiliary water supply is connected to a fire system.
- Systems in which chemical addition or antifreeze is allowed. In some jurisdictions, antifreeze is prohibited for use.

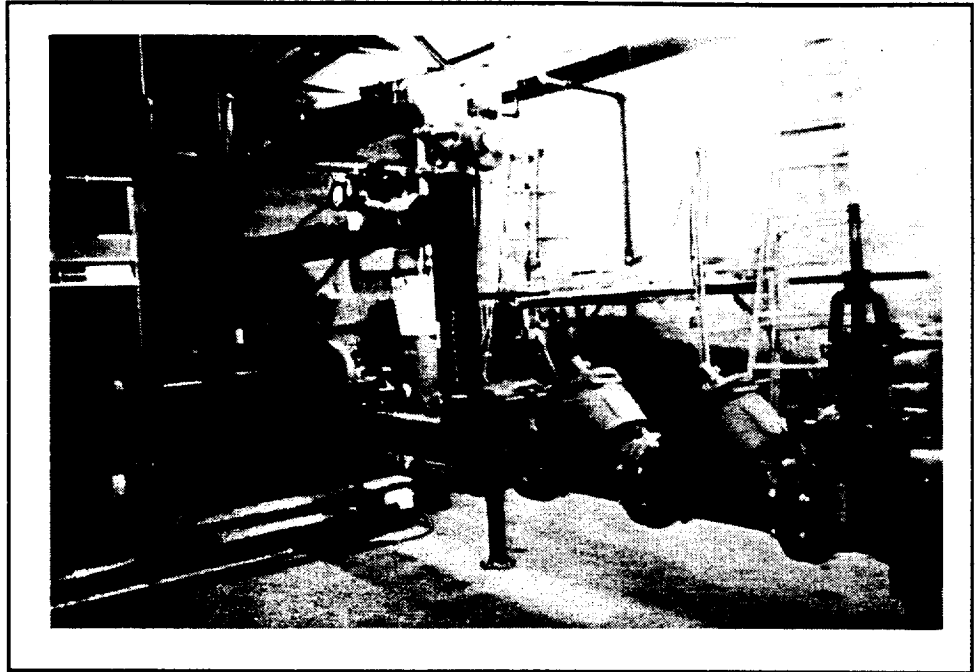


Figure 4-16: Typical Fire Sprinkler System With Double Check Valve Assembly.

** An RPBA or RPDA shall be installed on a high hazard fire system.*

*Backflow Protection Required
Reduced Pressure Backflow Assembly or
Reduced Pressure Detector Assembly.*

Low-Hazard Fire System

- All fire systems not included under "High Hazard Fire Systems."

*Backflow Protection Required
Double Check Valve Assembly or Double
Check Detector Assembly.*

Residential Fire Protection Systems

- Flow through systems using approved potable water pipe and materials.

*Backflow Protection Required
None.*

- All other systems without chemicals added.

*Backflow Protection Required
Double Check Valve Assembly.*

- Systems with chemicals added.

*Backflow Protection Required
Reduced Pressure Backflow Assembly.*

Dockside Watering Points - Marine Facilities - Boat Moorages

Actual or potential hazards to any water system created by any marine facility or dockside watering point must be protected against backflow. The basic risk to a potable water system is that contaminated water may backflow into the potable water system. This backflow could occur by means of auxiliary fire pumps, backsiphonage, or other pumps aboard ships or boats. In addition to the normal risk at dockside watering points, further risks are found in those areas where dockside watering facilities are used in connection with marine construction, maintenance and repair, and moorages. Minimum system protection for marine installations may be accomplished in one of the following ways.

Ships - Potable Water And Fire Protection

Water provided directly to ships for potable or fire purposes must have an approved RPBA or RPDA installed at the pierhead outlet or meter. In all cases, the RPBA or RPDA shall be above the 100 year flood level. Where there are provisions for two or more ships connecting to the same system, permanent or portable DCVAs shall be used at each pierhead outlet. However, an approved RPBA shall be installed between the first outlet and the potable water system (see Figure 4-17).

Marine Facilities - Fire Protection

Water provided to marine facilities under the following conditions must have an approved DCVA or DCDA installed at the pierhead outlet, meter, or at some other convenient location between the meter and the pierhead outlet:

- For fire protection only.
- Where no auxiliary supply is being used.
- There are no provisions for connecting directly to a ship's fire system.

If the system has an auxiliary supply such as fresh or salt water pumps, an approved RPBA or RPDA must be used in place of the DCVA or DCDA (see Figure 4-18).

Marine Repair Facilities - Potable Water

Water provided to marine repair facilities must have an approved RPBA installed in a location to protect the potable water system from any non-potable waters. If dockside watering points are available to the ships, an approved DCVA or DCDA must be used at each watering point (see Figure 4-19).

Small Boat/Pleasure Craft Marinas - Potable Water

Water provided to small boat moorages (Figure 4-20) is required to have an approved RPBA installed between the meter and the dock or float moorages.

If hose bibbs are installed on the watering system beyond the RPBA, hose bibb backflow devices are required on each hose bibb for proper backflow protection. When a sewage pump station is provided at the site, an approved RPBA is required between all potable water and the pump station. No direct connection between the potable water and the pump station shall be allowed.

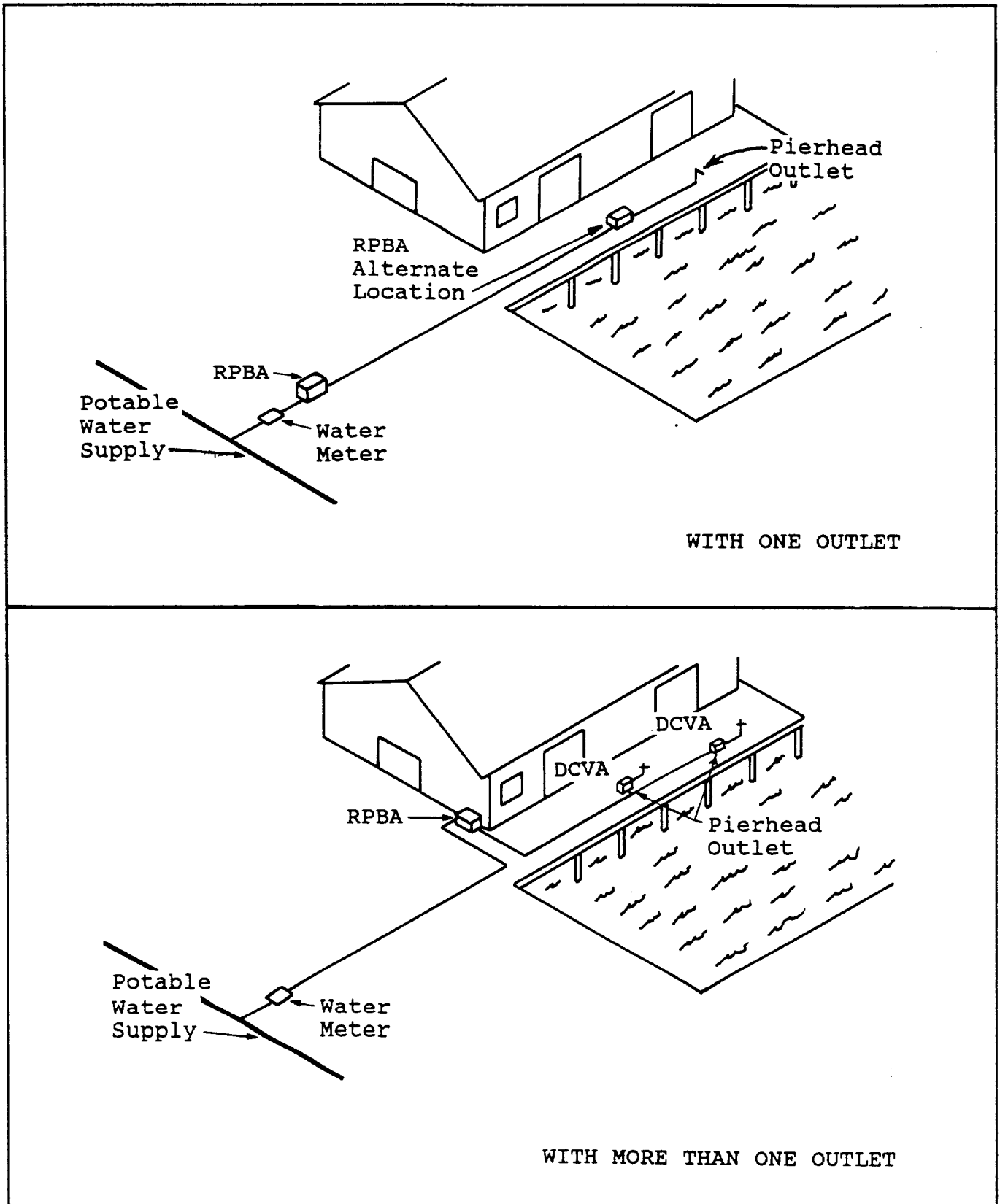


Figure 4-17: Water Service To Ships.

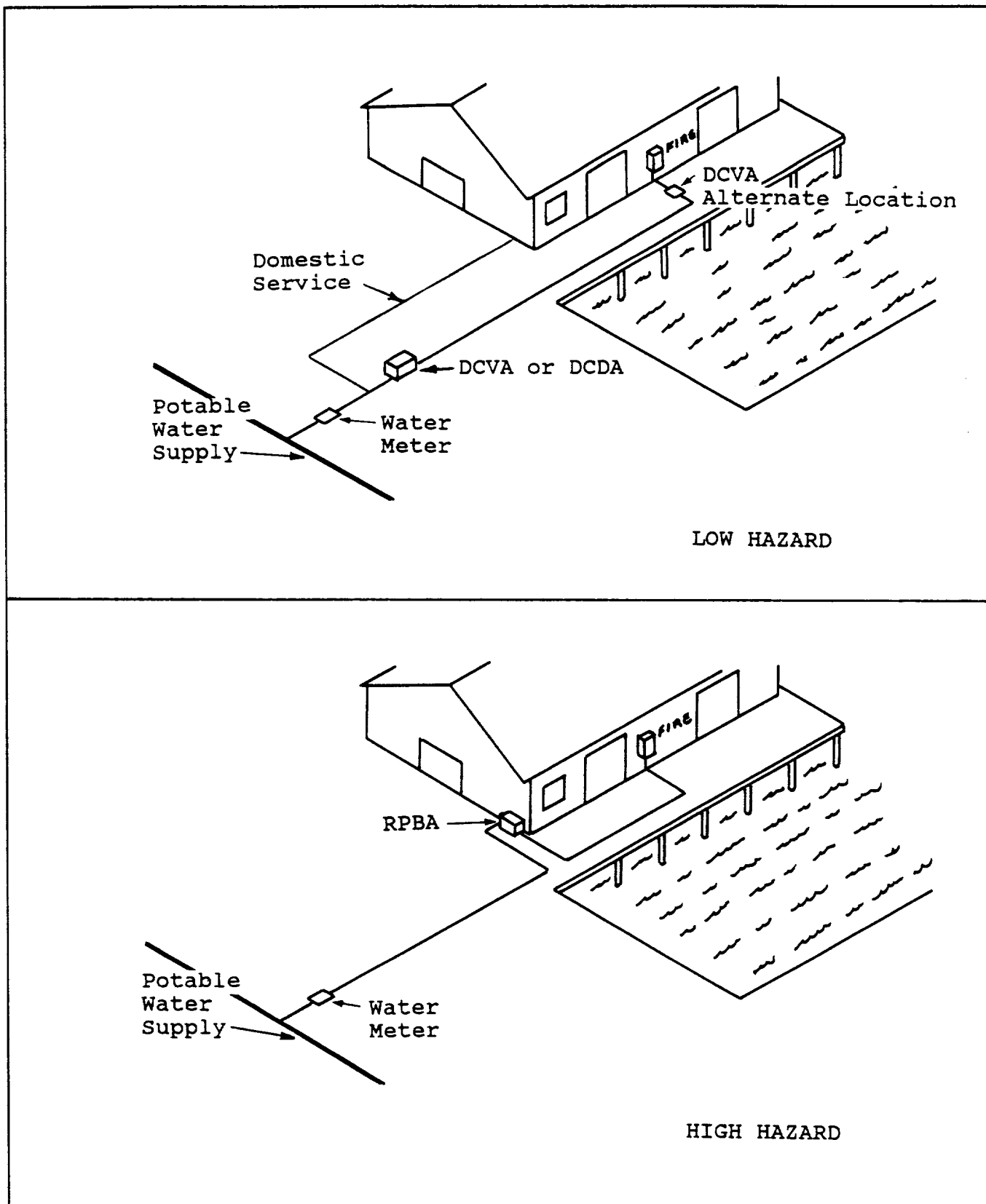


Figure 4-18: Fire Protection For Marine Facilities.

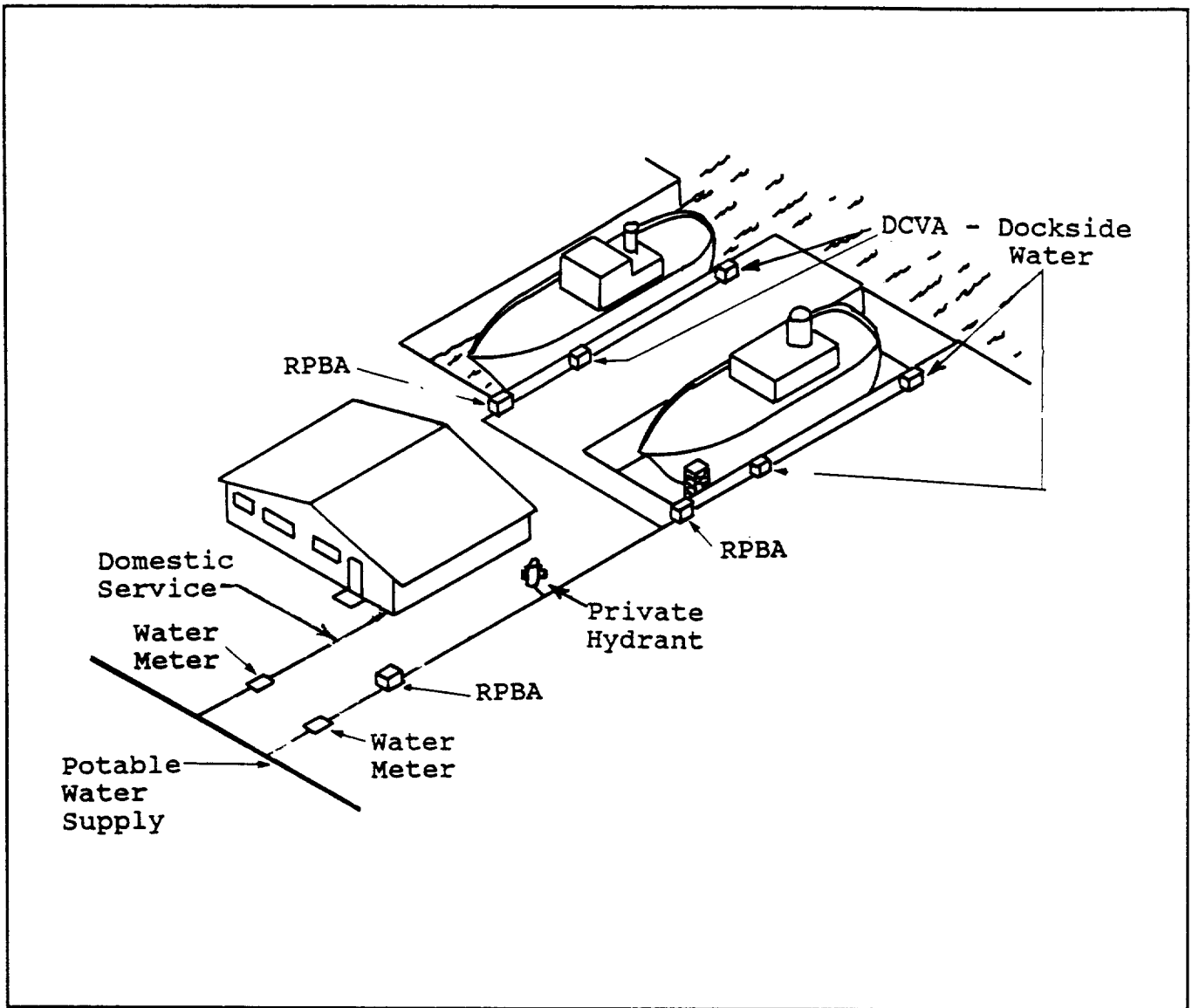


Figure 4-19: Typical Backflow Protection For Marine Repair Facilities.

Miscellaneous Use Of Water From Fire Hydrants

Portable Spray and Cleaning Equipment

Any portable pressure spray or cleaning unit that is capable of connecting to any potable water supply shall be fitted with a double check valve assembly if it does not contain an approved air gap. If chemicals are used, a reduced pressure backflow assembly must be used in place of the double check valve assembly.

Flushing Sewers

Many purveyors allow the use of water from fire hydrants for purposes such as flushing storm and sanitary sewers. Where this is permitted, an approved air gap shall be required to protect the potable system from backflow through the hydrant.

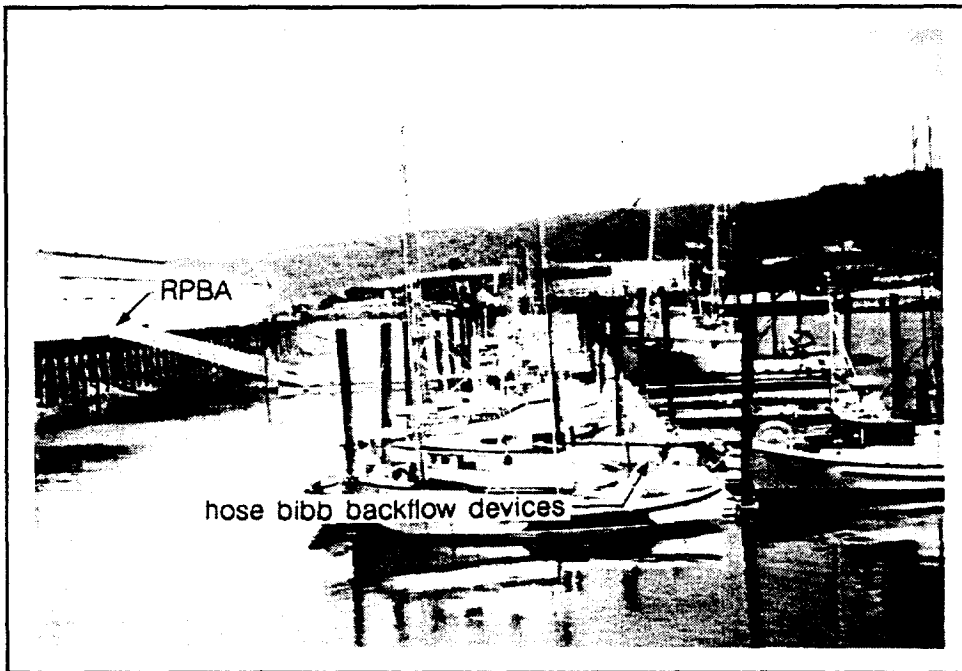


Figure 4-20: Small Boat And Pleasure Craft Moorage.

Filling Tanker Trucks Or Trailers

An approved air gap or double check valve assembly must be used when filling tanker trucks or trailers, which only carry potable water directly from hydrants (see Figure 4-21). If chemicals are added to the tank, an approved air gap or reduced pressure backflow assembly must be used.

New Water Main Construction

New sections of water main that are installed when expanding a distribution system must be separated from the existing system. Until satisfactory flushing, disinfection, and bacteriological sampling has been completed, the new water main must be considered contaminated. In addition, the chlorine concentration used for disinfection procedures (minimum 25 mg/l) makes the water non-potable.

An approved backflow prevention assembly must be used on the supplying water line when filling the new water main during disinfection and flushing (see Figure 4-22).

* "Direct Use" type solar potable hot water systems are not a potential cross connection, as they circulate potable water that is being used for potable hot water through the collector loop.

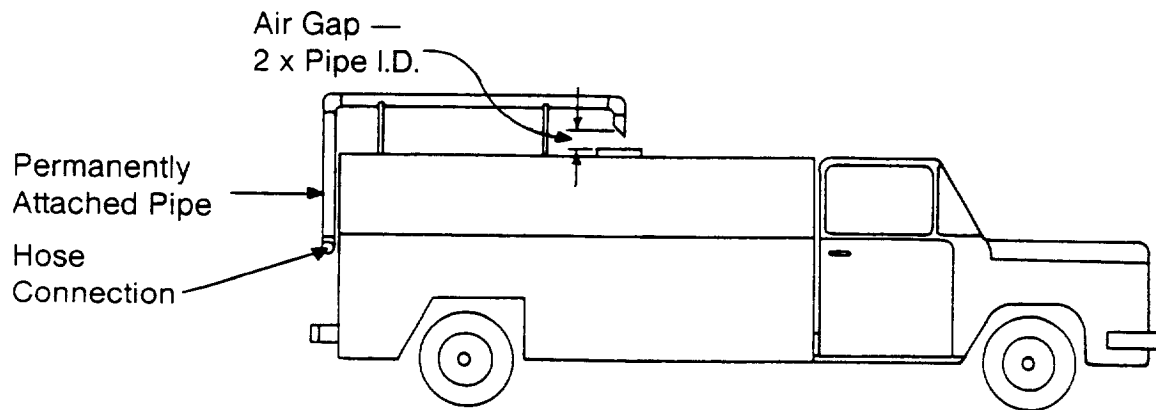
This prevents the new mains contaminated water from entering the existing system. The backflow prevention assembly and supply piping must be removed during hydrostatic pressure testing of the new water main.

After satisfactory bacteriological sample results are obtained from the new water main, a section of connecting pipe must be installed between it and the existing system. Before installation, the interiors of all pipe and fittings used to make the connection must be swabbed or sprayed with a 1% available chlorine solution.

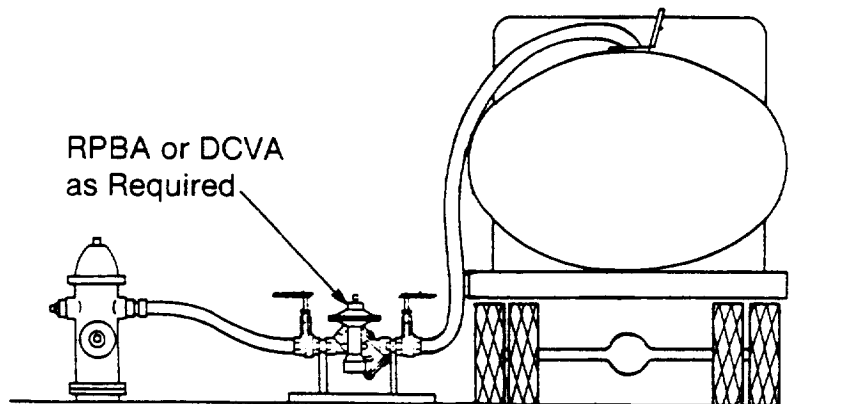
Heat Exchangers And Solar Potable Hot Water Systems

Heat exchangers physically separate one medium from another, and are used for heating or cooling a medium by transferring energy from one medium to another across an enlarged surface area. This is done by using liquid-to-liquid, air-to-liquid, or gas-to-liquid heat exchangers. This section will deal primarily with solar DHW systems.* However, this information is applicable to all systems which contain heat exchangers.

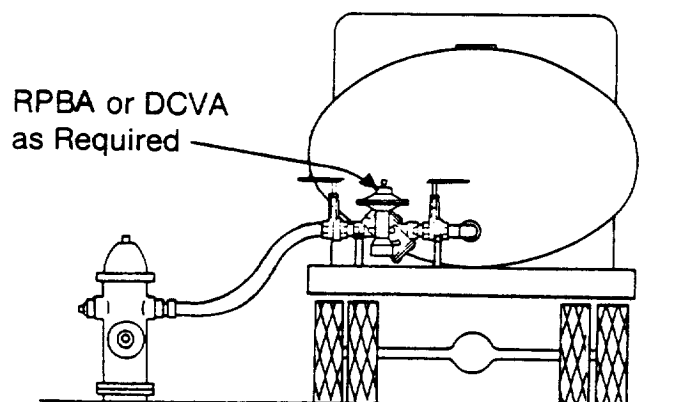
Heat exchangers have been used for years, primarily for industrial and commercial applications. With the advent of solar potable hot water systems (DHW), heat exchangers now have a residential application (see Figure 4-23). Whenever potable water is connected to a heat exchanger, or a heat exchanger is used to heat potable water, a



WITH AIR GAP



WITH PORTABLE ASSEMBLY



WITH TRUCK MOUNTED ASSEMBLY

Figure 4-21: Minimum Protection For Filling Tanker Trucks.

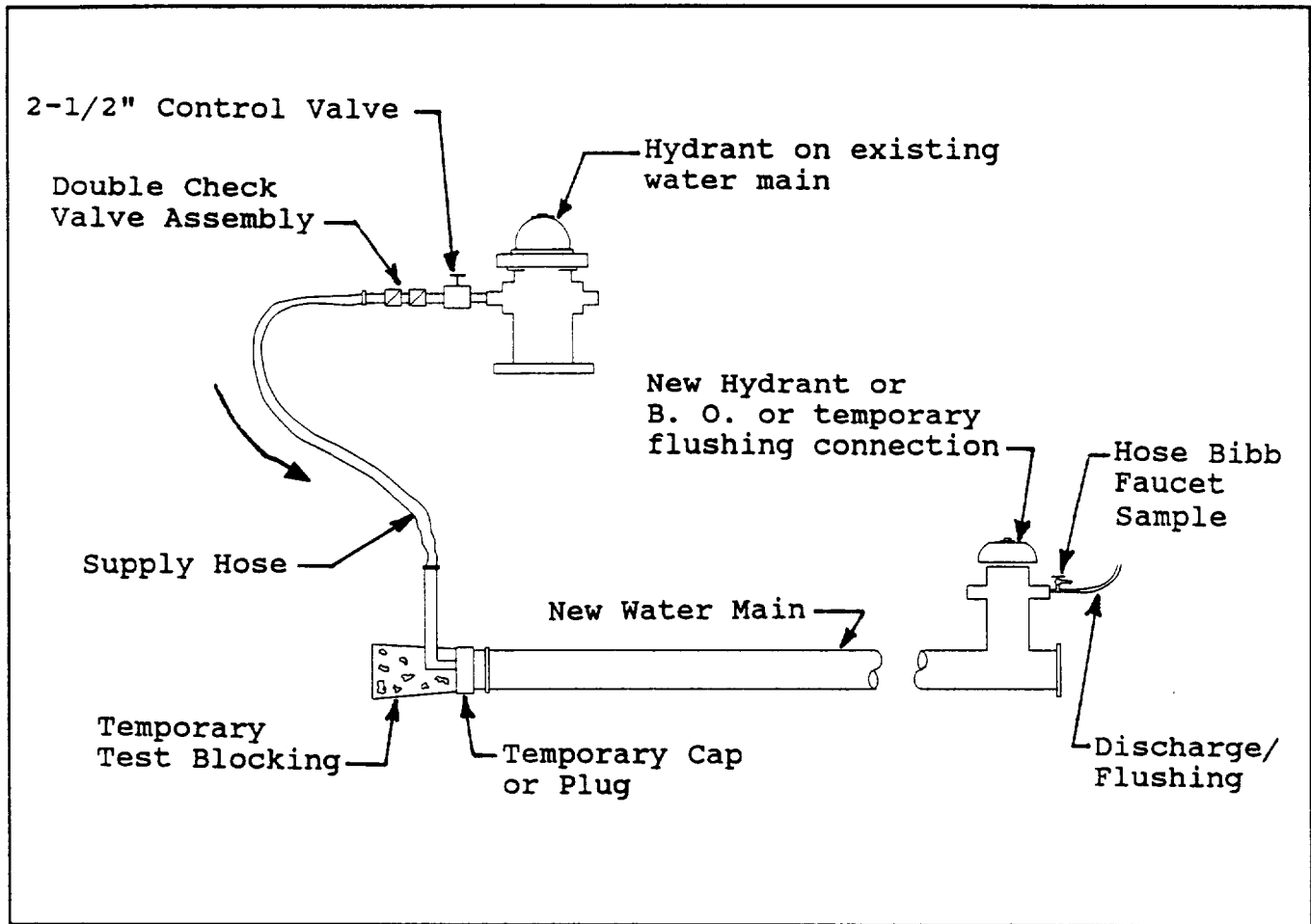


Figure 4-22: Method Of Filling New Water Mains.

hazardous cross connection may exist. Therefore, these heat exchangers must be examined closely and, if a potential cross connection exists, appropriate measures must be taken to protect the potable water supply.

Transfer mediums used will range from potable water to non-potable fluids containing corrosion inhibitors, antifreeze, and air or gases such as Freon. Hazards arise when a leak develops in the piping or tank walls separating the potable water from a non-potable medium. If this occurs, the two mediums can mix, contaminating the potable water supply. The level of hazard will vary, depending upon the toxicity of the non-potable medium.

For the purpose of these recommendations, heat exchangers will be classified as follows:

SW (single wall with no leak detection):

Provides a single wall separation between the transfer medium and potable water. Failure of this wall will result in the mixing of the potable water and transfer medium.

DW (double wall with no leak detection):

Provides two distinct walls which separate the transfer medium from the potable water. Contamination of the potable water from a non-potable heat transfer medium would require an independent failure of both walls.

DWP (double wall with leak detection):

Provides two distinct walls which separate the transfer medium from the potable water and a path to atmosphere. Failure of either wall is indicated by visual leakage of the transfer medium or potable

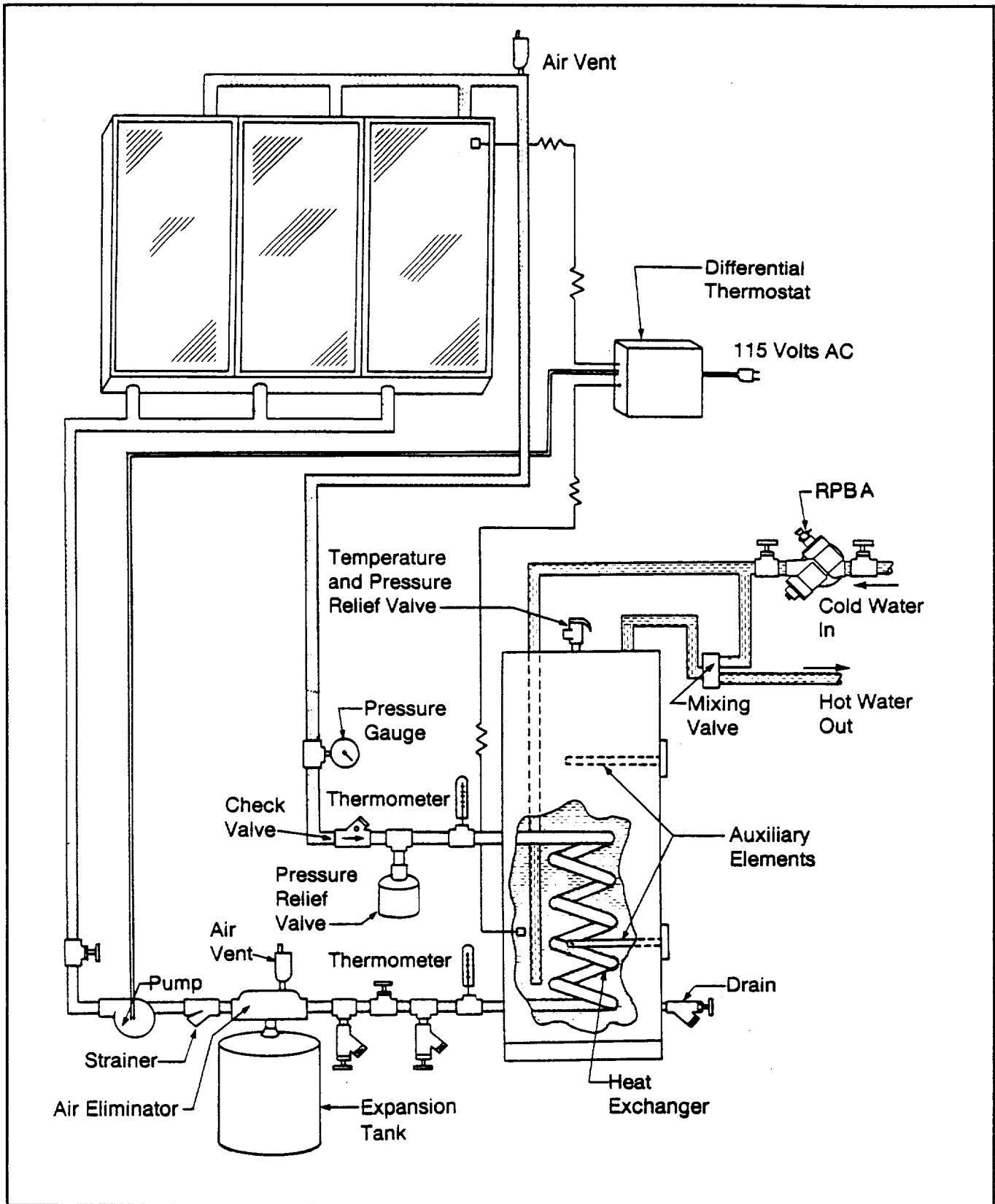
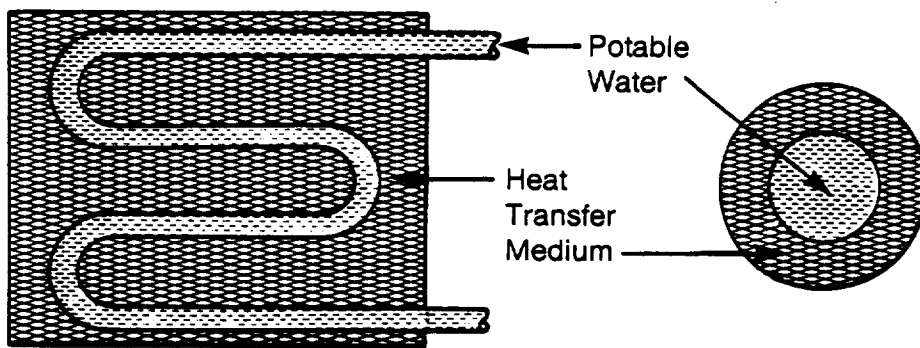
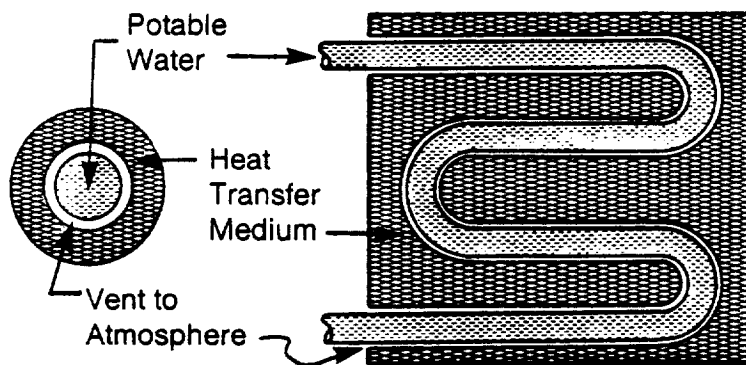


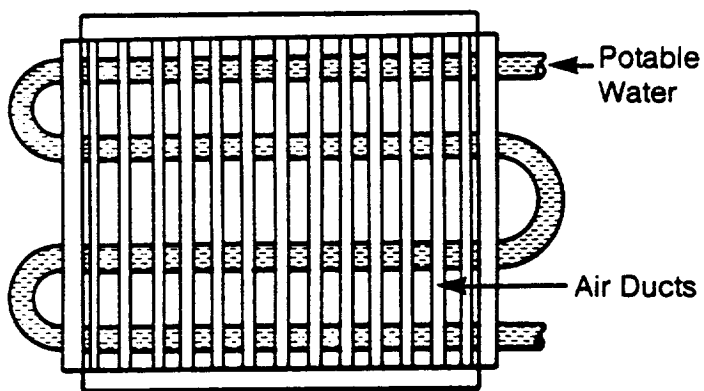
Figure 4-23: Typical Solar Domestic Water Heating System.



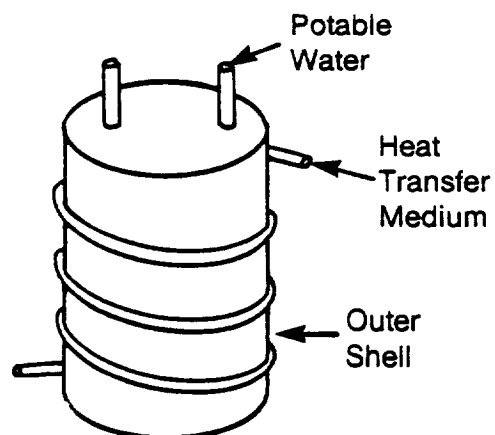
SINGLE WALL



**DOUBLE WALL WITH LEAK DETECTION
(IAPMO Approved)**



AIR TO LIQUID



WRAPAROUND

Figure 4-24: Examples Of Heat Exchanger Design.

water from the heat exchanger. This prevents contamination of the potable water and indicates a failure of the heat exchanger. The DWP type provides a higher degree of protection than the SW or DW types.

Heat exchangers bearing an IAPMO or equivalent label are generally the DWP type. When DW or DWP are required for adequate separation, extra thick single walls, or single walled configurations which rely upon potable water pressure to exceed that of the transfer medium, are not acceptable protection.

The use of the different types of liquid-to-liquid heat exchangers varies, depending upon the system design and required separation (see Figure 4-24). Some heat exchangers contain a transfer medium and are either wrapped around, or immersed in, a storage tank of potable water. Others may be designed with potable water contained in the heat exchanger which is immersed in a storage tank containing the transfer medium. Still others may use two heat exchangers, one containing the transfer medium and the other potable water. These may be immersed in a storage tank of water with tubes in continuous contact, or some other design which allows the heat to transfer from one medium to another. Air to liquid heat exchangers use air as a transfer medium. The air is fan forced through a heat exchanger containing potable water.

Transfer Mediums

Transfer mediums are liquid, gas, or air. These transfer mediums may be potable or non-potable, depending upon the system design. To provide freeze protection in some systems, the heat transfer fluid is drained out of the collector loop, or

a transfer medium of air, gas, water/glycol mixture, or some other freeze resistant fluid is used. Corrosion inhibitors are usually added in systems that conduct electricity. Whenever a freeze resistant fluid or corrosion inhibitor is used, or added to the transfer medium, the transfer medium must be considered non-potable. Although heat exchanger systems may be designed to use a non-toxic transfer medium, it is possible to add a toxic medium at a later date. Therefore, whenever any type of antifreeze is used, a DWP heat exchanger shall be used.

Toxicity of heat transfer fluids is generally based on the Gosselin rating system. Under this system heat transfer fluids are divided into the classes listed in Table 4-1. Materials which have Gosselin toxicity ratings greater than three (3) shall not be used. All additives, corrosion inhibitors, and residuals shall also be considered with the major component when classifying a fluid. A colored indicator should be provided in all Class II and III transfer fluids.

Recommended Protection

Heat Exchanger: The heat exchanger shall be designed for the transfer medium used. The consumer's hot water system in heat exchanger systems must be protected from possible contamination when non-potable transfer mediums are used. The only way to accomplish this is to use

Table 4-1: Heat Transfer Fluid Classes

Class	Material
Class I	Potable
Class II	Non-Toxic*
Class III	Toxic**

* Class II materials are typically materials with a Gosselin toxicity rating one (1) or less. Class II materials are considered non-potable and may be objectionable, but not dangerous to health. Examples of fluids that might be in Class II are Propylene glycol, mineral oil (USP), glycerine (USP), Polyvinylmethyl siloxane, polyalphaolefin fluids, and boiler water additives for steam boilers.

** Class III materials are those fluids with a Gosselin toxicity rating of (2) or three (3). They are considered non-potable and dangerous to health. Examples of fluids that might fall in Class III are Ethylene glycol and Hydrocarbon oils.

HEAT EXCHANGER TYPE _____	(fill in)
HEAT TRANSFER MEDIUM CLASS _____	(fill in)
<p>WARNING: NO OTHER MEDIUM SHALL BE USED THAT WOULD CHANGE THE ORIGINAL CLASSIFICATION OF THIS SYSTEM. UNAUTHORIZED ALTERATIONS TO THIS SYSTEM COULD RESULT IN A HAZARDOUS HEALTH CONDITION.</p>	

Figure 4-25: Permanently Affixed Label For Heat Exchangers.

heat exchangers which provide adequate separation between the two systems. The degree of protection a heat exchanger shall provide increases with the toxicity of the transfer medium. DWP heat exchangers offer the highest degree of protection for the consumer regardless of the transfer medium used. Whenever a packaged system's heat exchanger bears an IAPMO or equivalent label, it can be assumed that adequate protection in the form of DWP has been provided. However, caution should still be emphasized.

Table 4-2 shows the recommended heat exchangers for use with the four types of transfer mediums.

Backflow Protection: The type of backflow protection required depends upon the combination of transfer medium and heat exchanger used (see Table 4-3 on next page). If backflow protection is required, the backflow preventer may be installed on the potable water supply line to the heat exchanger, on the service line to the facility, or both. Protection on the service line will only protect the potable water supply; it offers no protection for the consumer's water system. All backflow preventers used shall be approved types and models. Periodic inspections shall be made on systems containing Class I and II ratings to insure that a higher class transfer medium has not been added. When heat exchangers are used, a permanently affixed label shall be provided at a prominent place in the system.

Table 4-2: Recommended Heat Exchangers

Transfer Medium	Recommended Heat Exchanger
Air	SW, DW, DWP
Class I (potable)	SW, DW, DWP
Class II (non-toxic)*	DW, DWP
Class III (toxic)	DWP

* Some jurisdictions may allow SW heat exchangers as adequate protection on systems using a gas (such as Freon) as a transfer medium.

Table 4-3: Recommended Heat Exchangers

Transfer Medium	Heat Exchanger	Recommended Protection
Class I	SW, DW, DWP	None*
Class II	SW	Double Check Valve Assembly*
Class II	DW, DWP	None*
Class III	SW, DW	Reduced Pressure Backflow Assembly
Class III	DWP	None*

* Some jurisdictions may require backflow protection.

** Some jurisdictions may allow a lower degree of backflow protection.

Notes:

Section 5

Safety

The safety procedures and information in this section are general suggestions for testing and repairing backflow prevention assemblies. The ultimate responsibility lies with each tester to work in a safe manner. The PNWS/AWWA Cross Connection Control Committee assumes no responsibility for any injury or damage to persons or property resulting from the use of this information.

Tools

Each tool is manufactured to perform a certain job. Use of the wrong tool may result in injuries to the worker and damage to the equipment being repaired. Therefore, always use the correct tool for the job you are trying to perform. When repairing backflow prevention assemblies, always consult the manufacturer's manuals for the proper tools and procedures to follow.

Assemblies And Springs

Safety precautions must be taken whenever the cover of a check valve is removed to clean or repair a backflow prevention assembly. Some disc modules are held in place by spring pressure. Larger assemblies have very heavy covers, and their springs may have a lot of tension on them. Special care must be taken to keep your hands and fingers from being pinched or cut while removing or reassembling these check valves. Always close both shutoff valves, and release any pressure from the assembly, before removing its cover.

The #1 check valve spring is stronger in reduced pressure backflow assemblies, creating enough pressure drop across the check valve for proper operation of the relief valve. On some older assemblies, the access cover is also the spring retainer. Use caution when removing the bolts on

their covers. It is recommended that two continuous-threaded rods be used to slowly remove the covers. On newer assemblies, the springs are retained by the check assembly. When the bolts on their cover are removed, the tension is released from the springs. They may be easily removed without danger to the repair person.

Remember that all replacement parts must meet the manufacturer's specifications to maintain the assembly's approval status.

Overhead Installations

Assemblies installed more than five (5) feet above floor or ground level must have a platform under them for the tester or maintenance person to stand on. This platform must meet all applicable safety standards and codes.

Some older installations may be over chemical vats, electrical systems, or in ceilings. Water discharging from these assemblies could cause property damage or present a hazard to the tester or maintenance person, so use caution.

Grounding And Electrical Hazards

In many areas it is common practice to ground the electrical system to the water piping system. When the grounding rod fails or the system shorts, an electrical charge may develop on the water piping system.

During the removal or testing of an assembly, you may become a better ground than the piping, particularly if you are standing in water. Under these circumstances, you will receive the electrical charge (see Figure 5-1).

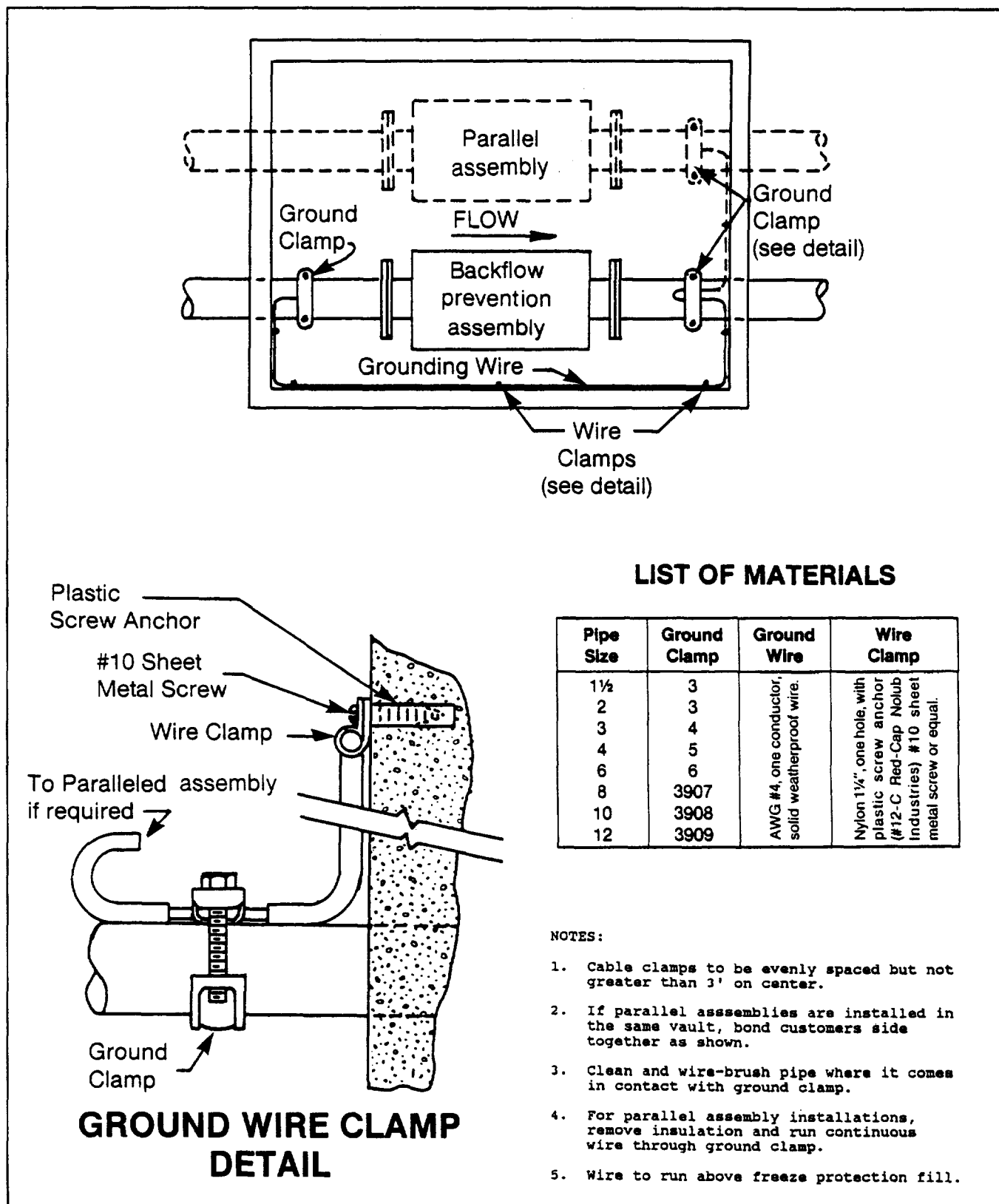


Figure 5-1: Ground Wire Installation.

Confined Space Entry

A confined space is defined as any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants, or an oxygen deficient atmosphere. Several examples of confined spaces include storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than four (4) feet in depth (pits, tubes, vaults, and vessels).

Hazard levels in these spaces may vary from "none" to "immediately dangerous to life." Table 5-1 shows how one agency, the National Institute of Occupational Safety and Health (NIOSH), rates the environment.

There are many hazards which may be encountered when entering a confined space. Following are several that must be watched for:

Atmospheric conditions: The normal oxygen level in our atmosphere is 20.9%. The minimum safe working level for oxygen is 18%. The oxygen level must always be checked before entering a confined space. Most oxygen meters will also test for inert gases and combustibles. These tests can all be performed at the same time.

Condition of entry steps/ladders: Steps and ladders may have been in these spaces for a long time. It is possible for them to deteriorate in the environment. Even a new ladder may have been installed wrong and be a hazard for the tester or maintenance person. Look for rust, broken steps, distance between steps, missing bolts, etc.

Table 5-1: NIOSH Confined Space Classification

Parameters	Class A	Class B	Class C
Characteristics	Immediately dangerous to life - rescue procedures require the entry of more than one individual equipped with life support equipment - maintenance of communication requires an additional standby person stationed within the confined space.	Dangerous, but not immediately life threatening - rescue procedures require the entry of no more than one individual equipped with life support equipment - indirect visual or auditory communication with workers.	Potential hazard - requires no modification of work procedures - standard rescue procedures - direct communication with workers, from outside the confined space.
Oxygen	16% or less or greater than 25%	16.1% to 19.4% or 21.5% to 25%	19.5% to 21.4%
Flammability Characteristics	20% or greater of LFL*	10% to 19% of LFL*	10% of LFL* or less
Toxicity	IDLH**	Greater than contamination level, referenced in 29 CFR Part 1910 Sub part Z - less than IDLH**	Less than contamination level referenced in 29 CFR Part 1910 Sub part Z

* Lower Flammability Level.

** Immediately Dangerous to Life or Health - as referenced in NIOSH Registry of Toxic and Chemical Substances, Manufacturing Chemists data sheets, Manufacturer's Safety data sheets, industrial hygiene guides, or other recognized authorities.

Spiders, rats, or snakes: These creatures like to live in confined spaces. Bites from spiders, rats, or snakes may be poisonous.

Lids and covers: Some vault lids or covers are very heavy. Be sure you have good footing before attempting to lift these lids or covers. Use proper lifting procedures.

Base or floor: Floors may consist of slippery mud, wood, or other material which could cause a slip or fall.

Access opening: In some installations, access points may be in unusual locations, or have an unusual size or shape. Know what you are getting into and set up your work for that situation.

Table 5-2 (end of section) is a check list of considerations which must be taken into account when entering, working in, and exiting confined spaces.

Assistance

A person must never be alone when working in a confined space. A second person must be available just outside the space where they can maintain visual and audio contact with the person in the confined space. It is the responsibility of the second person to monitor the person in the space, and to call for rescue in case of emergency.

Entry Procedure

This is one of several possible procedures for entering a confined space, and is presented here for your information.

NOTE

Exit immediately at the first sign of any questions or problems, and reevaluate the situation, to avoid injuries.

1. Set up signing and control of the area to keep the public from entering the space.
2. Test the atmosphere in the confined space for combustible gases and oxygen levels.
3. Set up the ventilation system and begin ventilating.
4. Set up safety lines and harness. Tie the line to a secured location. Do not tie the line to a vehicle unless movement can be prevented.
5. Review work and safety procedures with the safety person.
6. Retest the atmosphere in the space. Continue if safe. **Do not proceed until it is safe.**
7. Check the condition and safety of ladders or steps.
8. Proceed with work, keeping constant communication with the safety person.
9. Should the safety person lose communication with workers in a confined space, he should not enter the confined space to provide assistance since he could be exposed to unknown hazards such as low oxygen levels. **Under these circumstances, the safety person should immediately call for help (dial 911 where available).**

Safety Equipment

There are many companies which offer safety equipment. The following describes equipment needed to address the varying conditions of each installation. Each situation must be judged individually.

Ventilation: A ventilator should be used before and during any work in a confined space. Portable ventilation equipment is available to correct atmospheric hazards by injecting normal atmosphere **into** the confined space. This can be used to replace gases which may have accumulated, or to replace the oxygen level.

Gas/oxygen detection/sampling: Portable atmospheric monitors/testers are available to test and continuously monitor oxygen and combustible gas levels in the confined space. The monitor should be lowered into the space before entering, and remain in the space until all persons have exited the space. The atmosphere must be checked at all levels when entering very deep chambers. These monitoring units require routine calibration and adjustment.

Safety lines/harness: Safety lines and harnesses are used to remove injured workers from an area if they are unconscious or unable to exit. The harness must be a type which allows the worker to be pulled through a small opening or lid. This equipment must be inspected on a regular basis for damage or deterioration. Personnel using safety equipment should have hands-on training from qualified instructors.

Personal protection: Personal protective equipment should be included in any safety program. These items should always be included:

- Hard hat
- Gloves
- Foot protection
- Ear protection
- Protective clothing
- Self contained breathing apparatus

Be careful when selecting your protective equipment. Some rubber boots or cloth gloves do not provide protection from all chemicals.

Flammable atmospheres: If working in a flammable atmosphere, all tools and equipment must be approved for explosive atmospheres. They must also be properly grounded and bonded.

Employees must never enter an explosive atmosphere.

Hazardous Materials

Hazardous and toxic materials are becoming a big issue and, in many cases, are the reason backflow prevention assemblies are installed. With all the chemicals now in the work place, caution must be used when testing and servicing backflow prevention assemblies. You may not know what chemicals are around, in, or downstream of an assembly.

Most states or areas have a program to address situations when chemical exposure occurs. For instance, if you are exposed to a chemical, you have the right to know what the chemical is and the effects it will have. If you have questions, or believe you have been exposed to a chemical, you should contact your local or state health agency. Table 5-3 lists twenty five (25) common chemicals with their properties, physiological effects, source/conditions, testing methods, and a description of how to control or protect against them.

Other Recommended Publications

Where Available	Publication
N.I.O.S.H. (National Institute for Occupational Safety and Health)	"Working in Confined Spaces" December 1979 Publication #80-160 "Confined Spaces" Publication #87-113
Bureau of Business Practice 24 Rope Ferry Road Waterford, CT 06386 (800) 243-0876	"Handle Hazardous Materials with Care" Publication #HZB/0788
Bacharach, Inc. 625 Alpha Drive Pittsburgh, PA 15238 (412) 963-2000	"The Unseen Menace"
Research and Trading Corporation P. O. Box 445 Wilmington, DE 14899 (302) 762-4300	"Fall Protection Tips"
State of Washington Department of Labor and Industries Safety and Health Division Olympia, WA 98504 (800) 423-7233	"Right to Know for Small Business" "Understanding Right to Know" Chemical Hazard Communication Guidelines
Rice Safety Equipment Company 2523 N.E. Argyle Portland, OR 97211 (503) 284-7423	"Hazardous Materials Catalog Permeation and Degradation Chart"

Table 5-2: Check List Of Considerations For Entry, Working In, And Exiting Confined Spaces

Item	Class A	Class B	Class C
Confined Space Entry Permit (see Appendix)	X	X	X
Atmosphere Testing	X	X	X
Monitoring	X	*	*
Medical Surveillance	X	X	*
Training of Personnel	X	X	X
Labeling and Posting	X	X	X
Preparation			
• Isolate/lockout/tag	X	X	*
• Purge and ventilate	X	X	*
• Cleaning processes	*	*	*
• Requirements for special equipment/tools	X	X	*
Procedures			
• Initial plan	X	X	X
• Standby	X	X	*
• Communications/observation	X	X	X
• Rescue	X	X	X
• Work	X	X	X
Safety Equipment and Clothing			
• Head protection	*	*	*
• Hearing protection	*	*	*
• Hand protection	*	*	*
• Foot protection	*	*	*
• Body protection	*	*	*
• Respiratory protection	*	*	
• Safety Belts	X	X	X
• Lifelines, harness	X	*	
Rescue Equipment	X	X	X
Record Keeping/Exposure	X	X	

X = requirement

* = determination by the qualified person

Table 5-3: Common Dangerous Gas - Monitoring and Control

Gas	Chemical	Common Properties (Air = 1.00)	Physiological Effect	Common Source/Condition	Testing Method (Field)	Control/Protection
Low Oxygen	O ₂	Colorless, odorless, nonpoisonous, heavier than air (1.11)	Normal air 20.93%, minimum tolerance 12%, fatal \pm 6% and lower	Depletion displacement by other chemical absorption by chemicals, liquids (water), or bacteria	Oxygen level indicator	Ventilation supplied
Carbon Monoxide	CO	Colorless, odorless, explosive, lighter than air (.97)	0.2% causes unconsciousness, displaces oxygen in blood	Manufactured fuel gas gasoline combustion	CO ampoules	Ventilation supplied air in high concentrations
Carbon Dioxide	CO ₂	Colorless, odorless, nonexplosive, displaces oxygen, heavier than air (1.53)	Limit exposure to few minutes @ 10%, acts on nervous system for respiration	Sewer gas, carbonation gas (beverages), combustion or decomposition of carbon containing materials (fuel, plants, etc.)	Oxygen level indicator	Ventilation, supplied air in high concentration
Chlorine	Cl ₂	Greenish yellow gas, highly irritating, corrosive in presence of moisture, heavier than air (2.5)	Displaces oxygen, irritant at low levels, causes burning and scarring of membrane tissue, dangerous at 40 ppm within 30 minutes, fatal @ 1,000 ppm	Leaking storage facilities, sewage from users (canneries, manufacturing, cold storage, etc.)	Chlorine detector, ammonia vapors	Ventilation (with supplied air respirators (for Cl ₂))
Gasoline Vapor	C ₅ H ₁₂ C ₉ H ₂₀	Colorless, odor above .03% explosive, heavier than air (3 to 4.0)	Anesthetic effect when inhaled, 1.1% dangerous, 2.4% fatal	Leaking storage facilities, improper discharges from homes and business	Combustible gas indicator, gasoline indicator	Ventilation (with supervision)
Ethane	C ₂ H ₆	Colorless, odorless, explosive, heavier than air (1.05)	Displaces oxygen in blood, asphyxiant	Natural gas	Combustible gas indicator, ethane indicator	Ventilation (with supervision), supplied air
Nitrogen	N ₂	Colorless, odorless, nonflammable, normally 79% in air, lighter than air (.97)	Displaces oxygen in blood, asphyxiant	Sewer gas, natural in some rock layers	Oxygen level indicator	Ventilation
Hydrogen	H ₂	Colorless, odorless, flammable, explosive, lighter than air (.07)	Displaces oxygen in blood, asphyxiant	Manufactured gas	Combustible gas indicator	Ventilation
Methane	CH ₄	Colorless, odorless, explosive, lighter than air (.55)	Displaces oxygen in blood, asphyxiant	Natural gas, sewer gas, decomposition of carbon-containing materials (organic and plants)	Combustible gas indicator, oxygen level indicator	Ventilation, supplied air
Hydrogen Sulfide	H ₂ S	Rotten egg odor (low levels), colorless, explosive, poisonous, heavier than air (1.19)	Impairs sense of smell, rapidly paralyzes respiratory center, fatal in few minutes at .2%	Sewer gas, petroleum fumes from blasting, battery manufacturing (sulfuric acid), plating and electronic manufacturers	Hydrogen Sulfide indicator	Ventilation, supplied air

Table 5-3: Continued

Hydrogen Cyanide	HCN	Bitter almond odor, colorless, poisonous, explosive, lighter than air (0.9)	Asphyxiant, weakness, confusion, unconsciousness, attacks liver, kidney, cardiovascular and nervous system, rapidly fatal (inhalation, ingestion, skin absorption)	Electro plating, fumigation, silver extraction (photo and Xray developing waste recovery)	Level indicator tubes	Supplied air
Ammonia	NH ₃	Colorless, pungent odor, displaces oxygen, hazardous product, lighter than air (0.68)	Burns or blisters skin, irritates or damages lungs and mucous membranes	Fertilizers product, dye manufacturing or use, refrigerant and petroleum refining, drug and pesticides production, canneries and cold storage.	Level indicator tubes, oxygen level indicator	Supplied air, ventilation (with supervision) respirators for ammonia
Benzene	C ₆ H ₆	Carcinogen, hazardous product, colorless, flammable, characteristic odor, lighter than air (.88)	Central nervous system depression, hemorrhages (brain, urinary track, mucous membranes, and skin), anemia and blood changes, leukemia and bone marrow changes	Solvent for fats, ink, oil, paint, extraction of oil from seeds and nuts, manufacturing detergents, explosive and dye stuff, gasoline	Level indicator tubes	Supplied air, ventilation (supervised)
Toluene	C ₆ H ₅ CH ₃	Hazardous product, colorless, sweet pungent odor, flammable, lighter than air (0.87)	Irritation of skin, eyes, and respiratory system, removes lipids in skin (dries skin), central nervous system depression	Manufacturing of Benzene, solvent for paint and coating, component of automobile/aviation fuel	Level indicator tubes	Respirator (organic vapor) air, ventilation (supervised)
Xylene	C ₆ H ₄ (CH ₃) ₂	Hazardous product, colorless, flammable, lighter than air (0.86)	Irritation to eyes, nose and throat, drying of skin, hemorrhages (liquid absorption), central nervous system depression	Solvent; constituent paint, lacquers, inks, dyes, glues, cleaning fluids, fuels; manufacturing plastic material, and synthetic textile, perfumes, epoxy resins	Level indicator tubes	Respirator, supplied air, ventilation (supervised)
Bromine	Br ₂	Dark reddish brown, suffocating odor, volatile liquid, corrosive material, heavier than air (3.12)	Burns and blisters to skin, slow healing ulcers, high level exposure causes death by choking, cumulative properties, acne-like skin lesions.	Anti-knock gasoline additive manufacturing, bleaching fibers and silks (home and business) manufacture military gas, manufacture pharmaceuticals and pesticides	Level indicator tubes	Respirator, supplied air
Vinyl Chloride	CH ₂ CHCl ₂	Carcinogen, flammable gas, colorless, pleasant odor, heavier than air (2.2)	Frostbite of skin upon evaporation, irritation of skin and eyes, central nervous system depression, cancer of lung, lymphatic and nervous system, lightheadedness, dulling vision, nausea	Manufacture of polyvinyl chloride (pvc)(pipe, gloves, etc.) solvent for pvc	Level indicator tube	Supplied air, ventilation (supervised)

Table 5-3: Continued

Paint Thinner "MEK" (Methyl Ethyl Ketone)	"MEK"	Colorless, fragrant (mint-like), sharp odor, flammable, heavier than air (2.5)	Irritation of eyes and nose, attacks central nervous system and lungs	Solvent in nitrocellulose coating and vinyl film, smokeless powder manufacture, cements and adhesives, used in dewaxing of lubricating oil.	Level indicator tube	Supplied air, respirator (organic vapor) ventilation (supervised)
Paint Thinner "MIBK" (Methyl Isobutyl Ketone)	"MIBK"	Colorless, pleasant odor, flammable, heavier than air	Irritation of eyes and mucous membranes, attacks central nervous system	Solvent in paint, varnishes, lacquers	Level indicator tube	Supplied air, respirator (organic vapor) ventilation (supervised)
Perchloroethylene (Tetrachloroethylene)	$\text{Cl}_2\text{C} = \text{CCl}_2$	Carcinogen, colorless, characteristic odor, heavier than air (1.63)	Odor becomes inconspicuous after exposure, dry and scaly skin, irritation of eyes and nose, central nervous system depression, renal injury	Dry cleaning solvent, degreaser (metal cleaning), fumigant	Level indicator tube	Supplied air, respirator (chemical cartridge and organic vapor), ventilation (supervised)
Trichloroethylene	$\text{ClCH} = \text{CCl}_2$	Carcinogen, hazardous product, colorless, sweet odor, displaces oxygen, heavier than air (4.5)	Irritation of eyes, nose, and throat; repeated contact with skin causes dermatitis, central nervous system depression, National Cancer Institute warning, irregular heart beat and sleepiness	Solvent in vapor degreasing used in extracting caffeine in coffee, a drycleaning solvent, in production of pesticides, waxes, guns, tars, varnishes, and resins	Level indicator tube, oxygen displacement	Supplied air, respirator (organic vapor), ventilation (supervised)
Arsine	ASH_3	Colorless, garlic-like odor, flammable, toxic	Attacks blood, kidneys, liver; fatal in sufficient quantities	Metal pickling, chemical smelting and refining (Siltec and dry cleaners)	Level indicator tube	Supplied air, ventilation (supervised)
Phosphine	PH_3	Colorless, decaying fish odor, hazardous, toxic, flammable	Irritation of lungs, central nervous system depression, death from cardiac arrest; weakness, headache, vomiting, abdominal pain	Grain fumigation (insecticides and rodenticides), generation of acetylene, sulfuric acid, tank cleaning, and rust proofing		
Silene (Silane)	SiH_4	Unpleasant odor, toxic, flammable	Highly toxic by inhalation, ingestion, contact; highly irritating; asphyxiating vapor	Silicone fluids or resins, transistor manufacturing		Supplied air, ventilation (supervised)
Nitrogen Dioxide	NO_2	Pungent acrid odor, dark brown color, fuming liquid or gas, hazardous, heavier than air (3.2)	Irritation of eyes and mucous membranes; severe burns, ulcers of eyes, skin, and mucous membranes	Silos, nitric and sulfuric acid manufacturing, liquid propellant rocket fuel	Level indicator tube	Respirator (chemical cartridge), supplied air

Section 6

Requirements For Equipment Approval And Testing

Approval Of Assemblies

The term "Approved Assembly" shall mean any backflow prevention assembly which has satisfactorily completed laboratory and field tests by an independent laboratory recognized by the authority having jurisdiction. There are several testing laboratories that have facilities capable of approving backflow prevention assemblies. The University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCCHR) is such an organization. The USCFCCCHR may be contacted by writing to the Foundation at the University of Southern California, KAP 200 University Park, Los Angeles, California, 90089-2531.

Approved assemblies shall be shipped from the manufacturer with their shutoff valves and test cocks. This requirement eliminates the possibility of the assembly being installed without approved shutoff valves and test cocks.

Many states and provinces have established lists of approved assemblies. These lists are normally available through the state or provincial health authority, the local water purveyor, or local health authority.

Testing And Maintenance Of Assemblies

Each backflow prevention assembly shall be tested to insure that it functions properly:

- Upon installation
- After repairs
- After being relocated, moved, or reinstalled

- Annually
- More often if required by the local water purveyor

The assembly owner shall be notified prior to the date for annual testing. It is then the assembly owner's responsibility to acquire the services of a certified tester to test the assembly. If the test indicates the assembly must be repaired, a record of the repair work and a report of a satisfactory final test must be sent to the water purveyor (see "Backflow Assembly Test Report Form" in Appendix).

The annual testing of backflow prevention assemblies must be done prior to any repair work or flushing of the relief valve, to properly establish its operating status. Failure to test and maintain backflow prevention assemblies is grounds for the water purveyor to discontinue water service.

Certification Of Testers

To ensure continued satisfactory operation of backflow prevention assemblies, they must be periodically tested by certified individuals who understand their design and intended operation. A program for training individuals in the testing of backflow prevention assemblies, and current knowledge of the rules and regulations, is a satisfactory method of maintaining confidence in a testing program. Water purveyors should employ personnel certified as testers to perform spot checks on commercial testers working within their system.

The certification of personnel to test backflow prevention assemblies must be reviewed periodically to ensure that testers have maintained their knowledge of current testing procedures, rules, and regulations.

Falsified test reports, use of improper test procedures, or use of improper repair parts may be grounds for revocation of tester certification.

Monitoring Of Test Results

The results of all tests performed on backflow prevention assemblies must be recorded and monitored by the water purveyor. Several computer software programs are available for recording and monitoring these test results.

Test results must be monitored continuously to determine if any make or model of assembly, or any individual unit, has unsatisfactory performance. Although "approved assemblies" have a low failure rate, unusual installation conditions, (high or low flow rates, water hammer or excessive age) may result in relatively high failure rates. Assemblies that are showing marginal performance can be identified and repaired or replaced before they fail by examining their annual test results, and comparing these results to those from previous tests.

Calibration Of Testing Equipment

All equipment used to test backflow prevention assemblies should be calibrated on a yearly basis, after repairs, or more often if required by the local authority. Since a backflow prevention assembly can pass or fail its annual test by as little as 0.1 psi, it is recommended that the calibration of testing equipment also be certified by a testing agency approved by the local authority. The calibration results of testing equipment should be recorded and submitted to the local authority. A sample report form for equipment calibration is shown in the Appendix.

Calibration of test equipment is only valid if proper procedures are followed. The following procedures, recommended by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research, are provided for calibrating differential and duplex gauges.

Differential Gauge Calibration Check - Water Column

Refer to Figure 6-1 for an example of the equipment configuration for this test.

Materials:

- Two transparent tubes (approx. 1 inch diameter) minimum length of 5 feet
- Adapters from transparent tube to gauge, rubber stoppers, nipples, ell

Procedure:

1. Attach high side hose to base of one transparent tube.
2. Attach low side hose to base of second tube.
3. Fill transparent tubes with water.
4. Bleed air from gauge by opening high side bleed valve, then close. Open low side bleed needle valve and close.
5. Fill or drain transparent tubes to desired height "h" to maintain a difference in elevation between the two tubes.
 $27 \frac{3}{4}$ inch = 1.0 psi
 $55 \frac{1}{2}$ inch = 2.0 psi
 $83 \frac{1}{4}$ inch = 3.0 psi, etc.
6. Compare gauge reading to water column height "h," the two values should be the same.
7. If gauge requires adjustment, contact the gauge manufacturer or a qualified gauge repair shop.

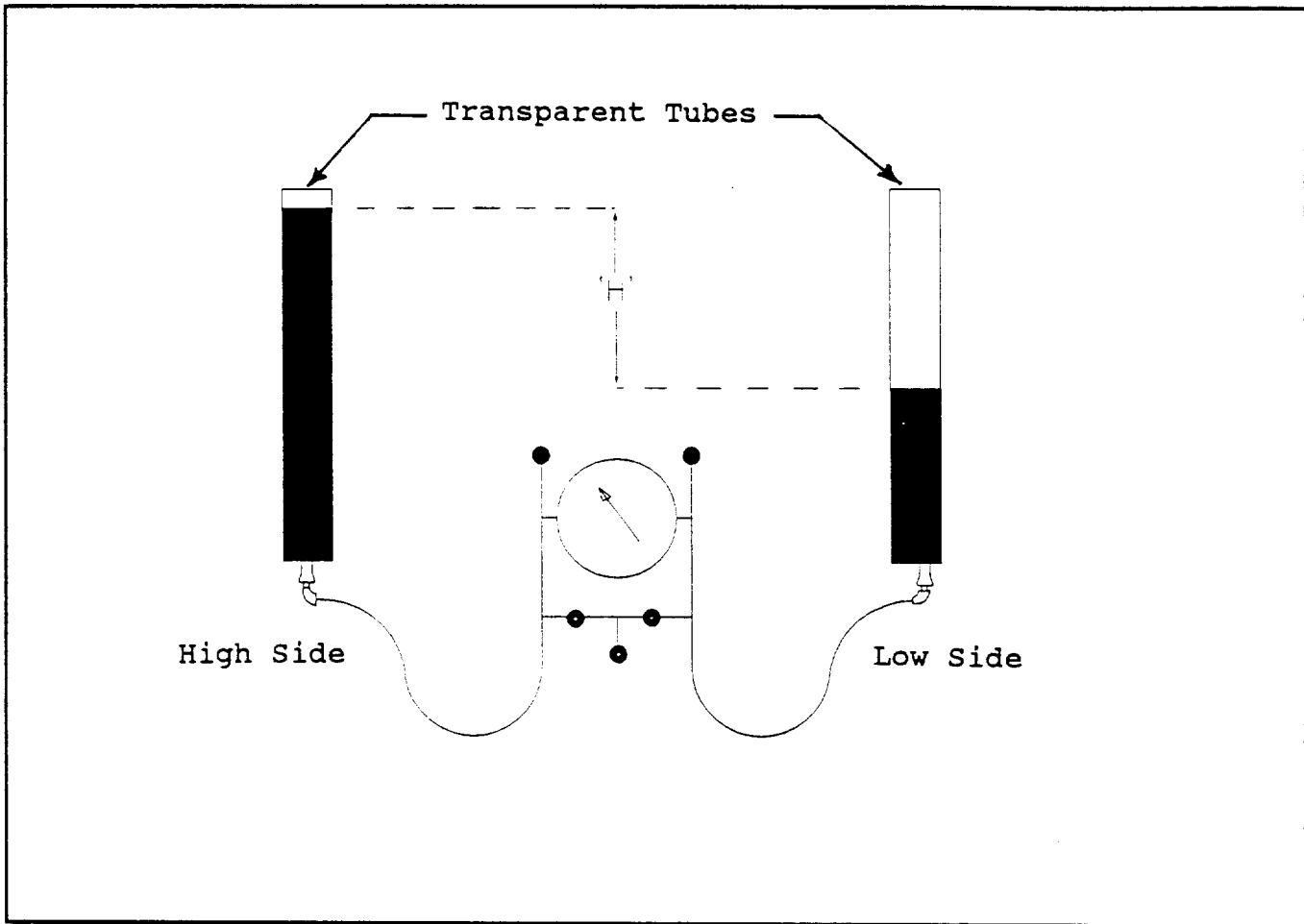


Figure 6-1: Differential Gauge Calibration; Water Column Method.

Differential Gauge Calibration Check - Mercury Manometer

Refer to Figure 6-2 for an example of the equipment configuration for this test.

Materials:

- Mercury manometer - minimum length 36"
- Appropriate fittings to attach gauge to manometer and pressure reducing valve
- Pressure reducing valve with proper range so that available line pressure can be reduced to 15 psi

Procedure:

1. Attached hoses from mercury manometer to crosses on either side of the pressure reducing valve.
2. Attach high side hose of the differential gauge to the upstream (high side) cross, and the low side hose to the downstream (low side) cross.
3. Set pressure reducing valve to open position (no pressure reduction).
4. Turn on inlet pressure.
5. Bleed air out of the manometer hoses by carefully opening the bleed valves at the top of each leg of the manometer.

Warning

Mercury is a hazardous material requiring special care in handling.

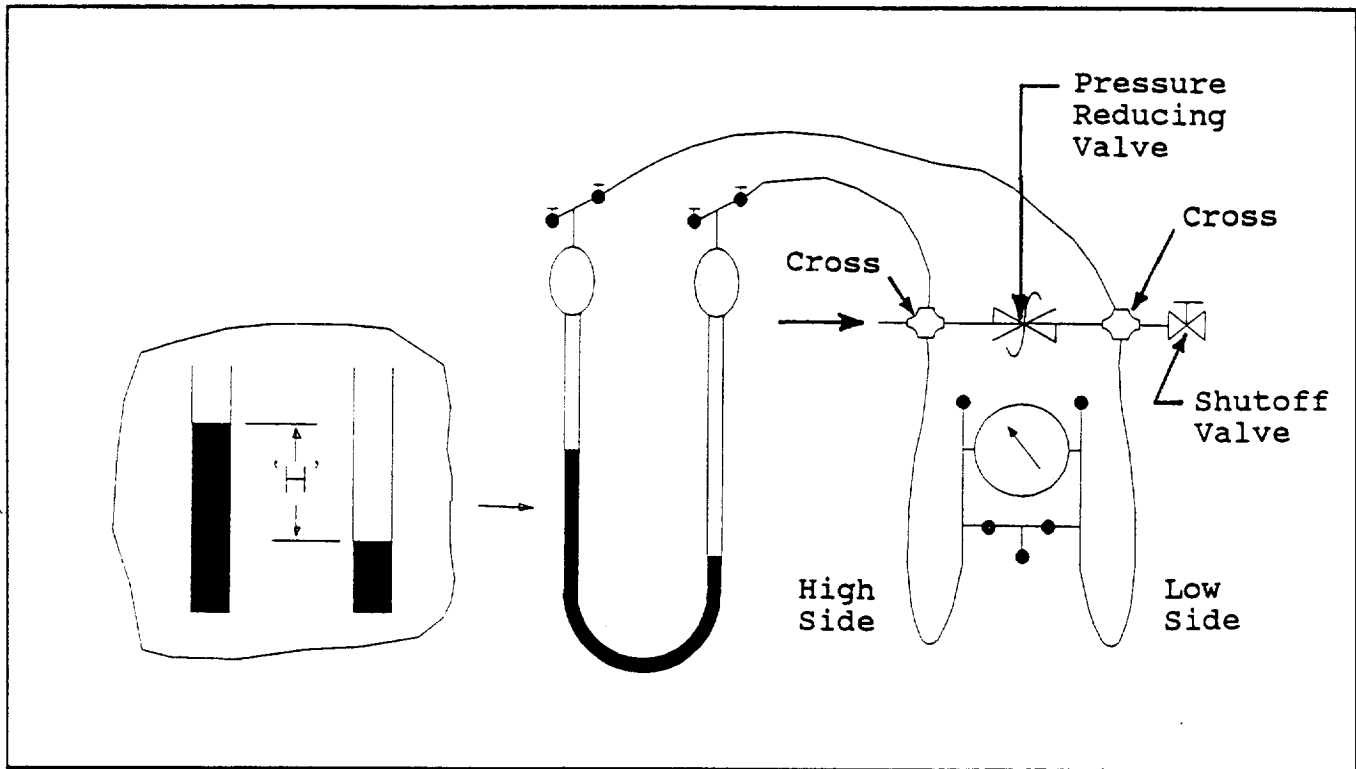


Figure 6-2: Differential Gauge Calibration; Mercury Manometer Method.

6. Bleed air from the differential gauge by bleeding through the high side hose first, then the low side hose. Both the manometer and the differential gauge should read 0.0 psid at this time.
7. Slightly open the low side bleed needle valve, and adjust the pressure reducing valve to establish a differential of approximately a 1.0 psid. Close the bleed needle valve.
8. Compare the values between the manometer and the differential gauge (i.e., measure the deflection of the mercury "h" and multiply by 0.455 to convert the value to psid). The manometer and differential gauge should be reading the same value.
9. Repeat steps #7 and #8 with greater differentials; 2.0, 3.0, 4.0, etc., up to 15.0 psid.
10. If gauge requires adjustment, contact the gauge manufacturer or a qualified gauge repair shop.

Duplex Pressure Gauge Calibration Check - Dead Weight Tester

Materials

- Dead weight tester with various weights so that the gauge can be tested throughout its entire range, (0 - 200 psi, 0 - 300 psi, etc.)
- Adapters to connect duplex gauge to dead weight tester

Procedures

1. Check the dead weight tester to make sure it is filled with clean oil.
2. Attached one gauge at a time (of two gauges in the duplex gauge) to the dead weight tester.
3. Add enough weights so that the gauge can be read from one end of the scale to the other. Select at least five (5) separate test points over the entire range while increasing the pressure. Then use the same test points for decreasing pressure.

4. Record the readings (see Appendix for Test Equipment Calibration form). If the gauge does not read accurately, the needle on the gauge must be removed and set properly. Some gauge needles have adjustment screws so the needle does not have to be removed.

Recommended Test Procedures For Backflow Prevention Assemblies

Initiating a cross connection control program without a backflow prevention assembly testing and maintenance schedule is like installing a fire sprinkler system and leaving the main line valve half closed. The potential protection is available, but during an emergency the equipment could not be depended upon to perform adequately.

Several methods may be used to test backflow prevention assemblies. To ensure that test results obtained from certified testers are reliable, standardized testing procedures must be used. For this reason, the following testing procedures for reduced pressure backflow assemblies, double check valve assemblies and pressure vacuum breaker assemblies are recommended in this manual. These procedures are published by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research. Also included are alternate test procedures that may be used in some jurisdictions to test double check valve assemblies and pressure vacuum breaker assemblies. The certified tester must verify with the local authority the acceptability of any alternate test procedure.

As a prelude to any field test procedure, it is essential to follow these basic steps:

1. **Notify:** The owner of the assembly must be notified that water service will be shut off during the test procedure. Special arrangements may have to be made so that interruption of service will not create a hardship to the user. If a fire sprinkler service is being shut down, the appropriate people must be notified.
2. **Identify:** Make sure the proper assembly is being tested by checking the identification tag for make (manufacturer), model, and serial number. Always record this information, as well as the test data, before leaving the location.
3. **Inspect:** Inspect the assembly for proper installation and for the required components to complete the field test procedure. This includes upstream and downstream shutoff valves, and properly located test cocks.
4. **Observe:** Carefully observe the area around the assembly for telltale signs of leakage such as moss or algae growth, plant life, or soil erosion. This information supplies the tester with additional information regarding an assembly's condition before testing is performed. For example, a wet spot under the relief valve port of a reduced pressure backflow assembly is an indication of relief valve activity, possibly from pressure fluctuations or fouling of the assembly. Proper testing will define the problem, if there is one.

Note

A field test of the duplex gauge can be done by hooking up both high side and low side hoses to the same pressure through a tee. Both gauges must read the same value. Should the needle indicate different values while hooked up to the same pressure, contact the gauge manufacturer or a qualified repair shop for proper maintenance and calibration.

Refer to Section 6 of the ANSI/ASME Standard B40.1-1985 for more information regarding pressure gauge testing.

Test Procedure For Reduced Pressure Backflow Assembly Using Differential Pressure Gauge

Figure 6-3 shows the equipment setup for testing a Reduced Pressure Backflow Assembly using a differential pressure gauge.

Equipment Required

- Differential Pressure Gauge - 0 - 15 PSID (0.1 or 0.2 psid graduations)
- Three - 6 ft. lengths - minimum $\frac{1}{4}$ " I.D. high pressure hose with screw type couplings
- $\frac{1}{4}$ " needle valves, for fine control of flows
- Three - $\frac{1}{4}$ " IPS x inverted flare (oxygen fitting, B-size, from welding) - brass or $\frac{1}{4}$ " IPS x 45° SAE flare connector - brass
- Adapter fittings for each test cock size - brass $\frac{1}{8}$ " x $\frac{1}{4}$ ", $\frac{1}{4}$ " x $\frac{1}{2}$ ", $\frac{1}{4}$ " x $\frac{3}{4}$ "

Test #1

Purpose: To test the operation of the differential pressure relief valve.

Requirement: The pressure differential relief valve must operate to maintain the "zone" between the two check valves at least 2 psi less than the supply pressure.

Steps:

1. Open test cock #4 to establish flow through the unit, then flush water through test cocks #1, #2, and #3 by opening and closing each test cock one at a time to eliminate foreign material. Be careful not to dump the relief valve during this process (open #2 test cock slowly). Close test cock #4.
2. Install appropriate fittings.
3. Install hose from the high side of the differential pressure gauge to the #2 test cock.
4. Install hose from the low side of the differential gauge to the #3 test cock.
5. Open test cock #3 slowly and bleed all air from the gauge and hose through the low side bleed needle valve. Maintain the low side bleed needle valve in the open position while test cock #2 is opened slowly. Open the high side bleed needle valve to bleed the hose and gauge. Close the high side bleed needle valve, then close the low side bleed needle valve after the gauge has pinned at the upper end of the scale.
6. Close #2 shutoff valve.
7. Observe the apparent pressure drop across the #1 check valve. During all subsequent steps of this procedure the differential gauge is "on line," showing the pressure drop across the #1 check valve.
8. Open the high side control needle valve, and then open the low side control needle valve no more than one-quarter ($\frac{1}{4}$) turn to bypass water from the #2 test cock to the #3 test cock. If the low side control needle valve must be opened more than one-quarter ($\frac{1}{4}$) turn, refer to the instructions for leaking #2 shutoff valve.
9. Watch the differential pressure drop slowly to the relief valve opening point. Record this opening point value on the test report form.
10. Close the needle valves.

Note

During this test the tester must not cause the relief valve to discharge before step "9" above or an accurate reading will not be obtained from steps 8 through 10.

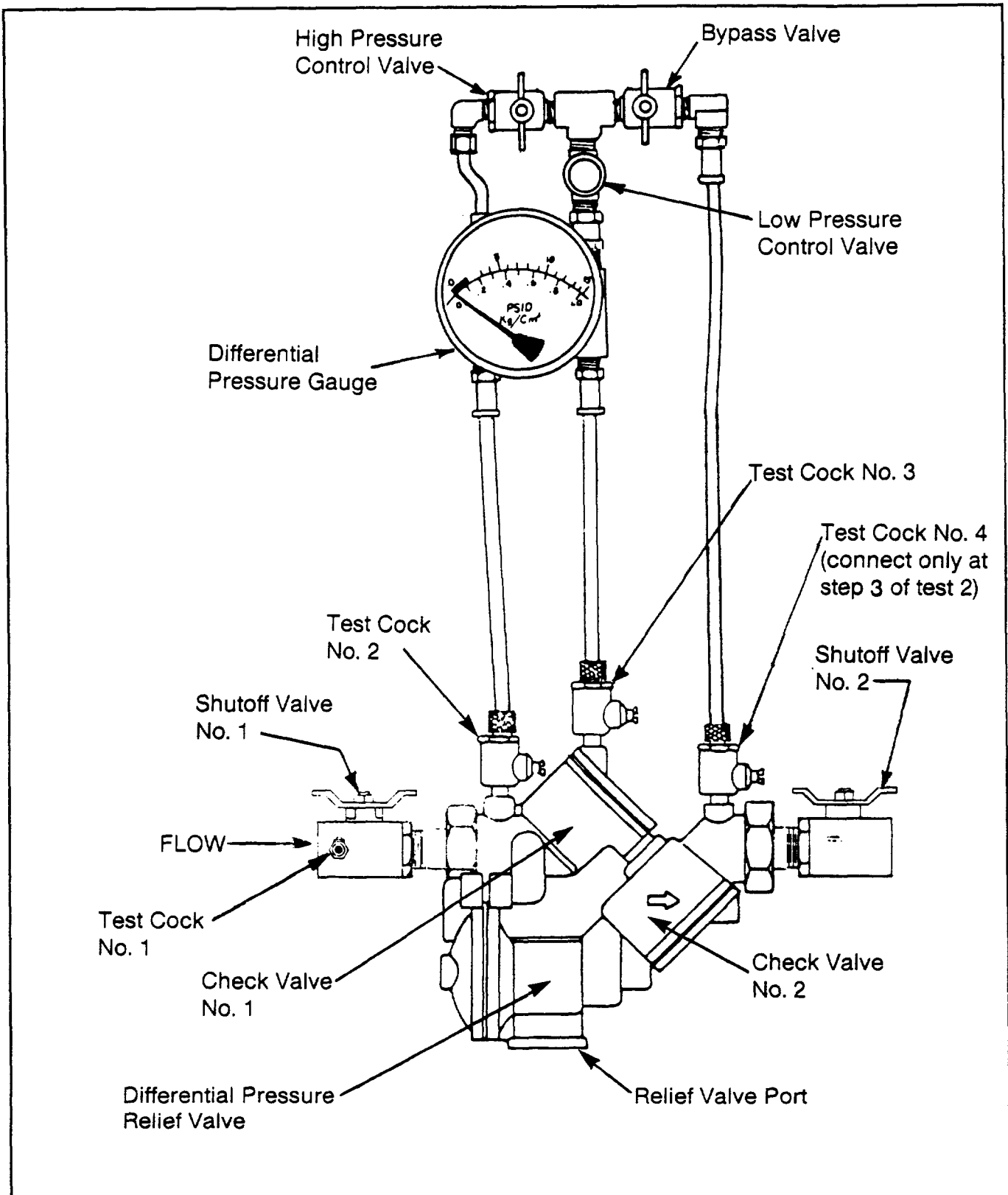


Figure 6-3: Setup For Testing Reduced Pressure Backflow Assembly Using Differential Pressure Gauge.

Test #2

Purpose: To test check valve #2 for tightness in reverse flow.

Requirement: The #2 check valve shall be tight against reverse flow under all pressure differentials.

Steps:

1. Maintain the #2 shutoff valve in a closed position (from test #1).
2. Vent all air from the bypass hose by opening both the high side control needle valve and the bypass needle valve. Close the bypass needle valve only.
3. Install the bypass hose from the gauge manifold to the #4 test cock, then open the #4 test cock.
4. Bleed water from the "zone" by opening the low side bleed needle valve on the gauge, reestablishing the normal reduced pressure within the "zone". Once the gauge reaches the high end of the scale, close the low side bleed needle valve.
5. Open the bypass needle valve. If the indicated pressure differential remains steady, report the #2 check valve as "closed tight." If the pressure differential falls to the relief valve opening point, note the #2 check valve as leaking, and do not complete Test #3 below. If the pressure differential drops, but stops above the relief valve opening point, the #2 check valve can still be reported as "closed tight." See the troubleshooting section (Section 7) for a further explanation of disc compression.

Test #3

Purpose: To test check valve #1 for tightness.

Requirement: The static pressure drop across check valve #1 should be at least 3.0 psi greater than the relief valve opening point (Test #1). This

3.0 psi "buffer" will prevent the relief valve from discharging during small fluctuations in upstream line pressure. A "buffer" of less than 3.0 psi does not imply a leaking check valve #1 (i.e. allowing backflow), but rather, is an indication of how well check valve #1 is holding.

Steps:

1. With the bypass hose connected to test cock #4 as in step 3 of Test #2 above, bleed water from the "zone" through the low side bleed needle valve on the gauge until the gauge reaches the high end of the scale. Close the low side bleed needle valve. After the gauge needle settles, the steady state pressure differential indicated (needle is not falling on the gauge) is the actual static (i.e., no flow) pressure drop across check valve #1, and is to be recorded as such.
2. Close all test cocks, open shutoff valve #2, and remove all test equipment.

Test Procedure For Double Check Valve Assembly Using Duplex Gauge

Figure 6-4 shows the equipment setup for testing a Double Check Valve Assembly using a duplex gauge.

Equipment Required

- A calibrated duplex gauge, or a pair of calibrated bourdon tube gauges having 1 or 2 psi increments and an adequate range to handle the expected maximum water pressure. Minimum 4 1/2" diameter
- 1/4" needle valves, for fine control of flow
- Three lengths, approximately 5 feet each, of high pressure hose with screw type couplings
- Six 1/4" x 1/4" inverted flare fittings (welding supply - oxygen fitting), or 1/4" x 45 degree SAE flare connectors
- Adapter fittings for each test cock size - brass 1/8" x 1/4", 1/4" x 1/2", 1/4" x 3/4"

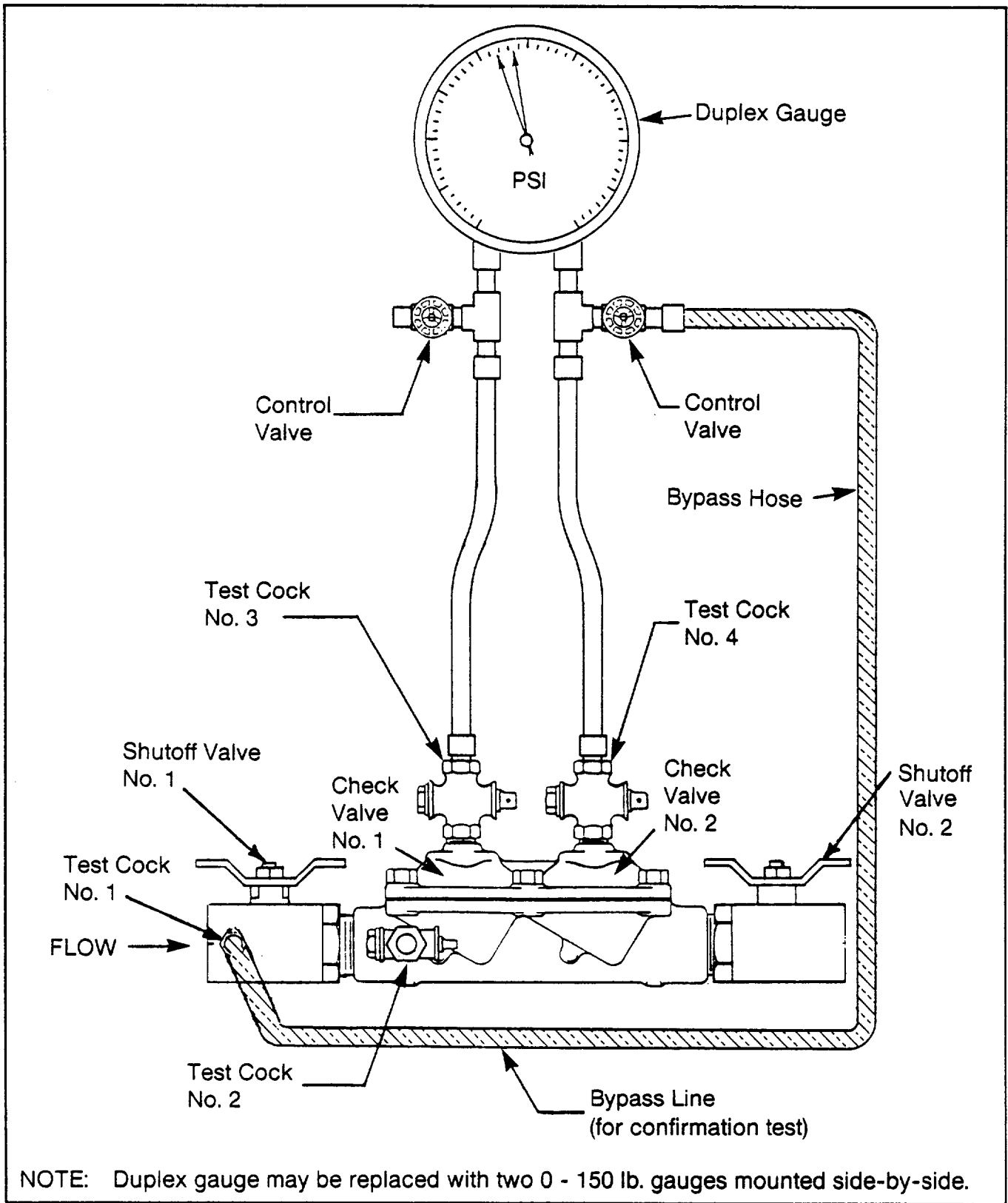


Figure 6-4: Setup For Testing Double Check Valve Assembly Using Duplex Gauge.

Test #1

Purpose: To test check valve #1 for tightness in reverse flow.

Requirement: The check valve shall be tight against reverse flow under all pressure differentials.

Steps:

1. Bleed water through all four test cocks to eliminate foreign material.
2. Install appropriate fittings.
3. Connect high side hose to test cock #2 and connect the low side hose to test cock #3. Connections must be drip tight.
4. Open test cocks #2 and #3, then bleed air from hoses.
5. Close #2 shutoff valve; then close #1 shutoff valve.
6. Using the high side needle valve, lower the pressure at test cock #2 about 2 psi below the pressure at test cock #3 (Refer to trouble shooting comments regarding disc compression). If this small difference can be maintained, then check valve #1 is reported as "tight" or "OK." Proceed to Test No. 2. If this small difference cannot be maintained, refer to step 7.
7. Open shutoff valve #1 to repressurize the assembly.
8. Loosely attach the bypass hose to test cock #1, and bleed from the gauge through the bypass hose by opening the low side needle valve to eliminate trapped air. Close the low side needle valve. Tighten the bypass hose. Open test cock #1.
9. Close shutoff valve #1.
10. By loosening the low side hose at test cock #3, lower the pressure in the assembly about 10 psi below normal line conditions.
11. Simultaneously open both needle valves very slowly. If the check valve is holding tight, the high pressure gauge will begin to drop while the low pressure gauge will increase. Close the needle valves. If the gauge shows that a small (no more than 5 psi) backpressure is created and held, then the check valve is reported as "tight" or "OK." If the check valve leaks, a pressure differential is not maintained as both gauges tend to equalize or move back toward each other, then the check valve is reported as "leaking." With both needle valves open enough to keep the needles on the gauge stationary, the amount of leakage is visible as the discharge from the upstream needle valve.
12. Close all test cocks, remove all equipment, and reopen shutoff valve #1.

Test #2

Purpose: To test check valve #2 for tightness in reverse flow.

Requirement: The check valve shall be tight against reverse flow under all pressure differentials.

Steps:

1. The steps for testing check valve #2 are exactly the same as those for check valve #1 with one exception. The high side hose is connected to test cock #3 and the low side hose is connected to test cock #4. The bypass hose is again connected to test cock #1 for steps 8 through 11.
2. Return the assembly to normal operating conditions.

Test Procedure For Pressure Vacuum Breaker Assembly Using Differential Pressure Gauge

Figure 6-5 shows the equipment setup for testing a Pressure Vacuum Breaker Assembly using a differential pressure gauge.

Equipment Required:

- Differential Pressure Gauge - 0 - 15 PSID (0.1 or 0.2 psid graduations)
- 1 - 6 ft. length - minimum 1/4" I.D. high pressure hose with screw type couplings
- 1/4" needle valves, for fine control of flows
- 1/4" IPS x inverted flare (oxygen fitting, B-size, from welding) -brass or 1/4" IPS x 45° SAE flare connector - brass
- 90° street ell

Note

For both of the following tests, the differential pressure gauge must be held at the same level as the assembly being tested. Be sure that all hoses are also kept at this level.

Test #1

Purpose: To test the opening pressure of the air inlet valve.

Requirement: The air inlet valve shall open when the pressure in the body is no less than 1.0 psi above atmospheric pressure, and the air inlet valve shall be fully open when the water drains from the body.

Steps:

1. Bleed water through both test cocks to eliminate foreign material.
2. Install appropriate fittings.
3. Remove the air inlet valve canopy.

4. Install the high side hose of the differential pressure gauge to test cock #2. Open test cock #2 and bleed air from the hose and gauge.
5. Close shutoff valve #2, then close shutoff valve #1.
6. Slowly open the high side bleed needle valve, being especially careful not to drop the pressure differential too fast. Record the pressure differential at which the air inlet valve opens. See the trouble shooting section if the high side bleed needle valve must be opened more than 1/4 turn to get the pressure to fall in the body.
7. Close test cock #2 and remove test equipment.
8. Open shutoff valve #1.

Test #2,

Purpose: To test the check valve for tightness in the direction of flow.

Requirement: The check valve shall be drip tight in the normal direction of flow when the inlet pressure is 1 psi and the outlet pressure is atmospheric.

Steps:

1. Attach high side hose of differential pressure gauge to test cock #1, open test cock #1, and bleed all air from the hose and gauge by opening the high side bleed needle valve. Close high side bleed needle valve.
2. Close shutoff valve #1.
3. Open test cock #2. The air inlet valve will open and the water in the body will drain out through test cock #2. When this flow of water stops, the differential pressure indicated by the gauge (after it has settled) is the pressure drop across the check valve. This value must be 1.0 psi or greater. Record this value. See the troubleshooting section if water continues to flow out of test cock #2.

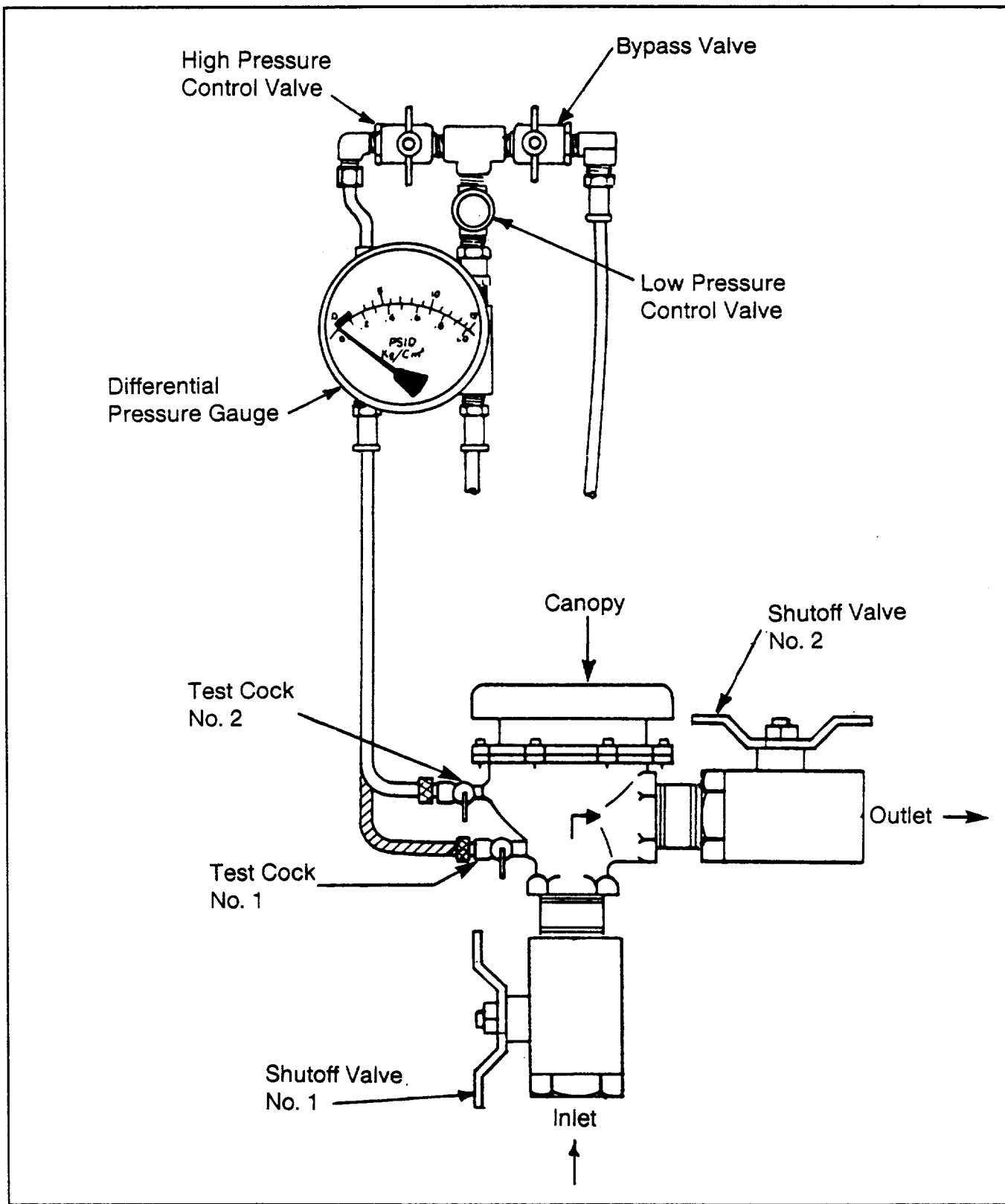


Figure 6-5: Setup For Testing Pressure Vacuum Breaker Assembly Using Differential Pressure Gauge.

4. Close test cocks #1 and #2, and remove equipment.
5. Open shutoff valve #1, then shutoff valve #2.
6. Replace air inlet canopy.

Alternate Test Procedures For Backflow Prevention Assemblies

In addition to the test procedures recommended by The University of Southern California Foundation for Cross Connection Control and Hydraulic Research, there are other test procedures which may be used in some areas. This is not a complete list of available test procedures, nor are these procedures endorsed by the Pacific Northwest Section of the American Water Works Association. Check with the responsible local authority before using these test procedures.

Test Procedure For Double Check Valve Assembly Using Sight Tube

Figure 6-6 shows the equipment setup for testing a Double Check Valve Assembly using a sight tube.

Equipment Required:

- Sight tube (consists of a 1" diameter clear plastic tube about 30" long)
- Appropriate fittings to attach sight tube to the test cocks of the double check valve assembly

Test:

Purpose: To test check valve #2 for one psi differential in direction of flow, and to test check valve #1 for 1 psi differential against reverse flow.

Requirement: Check valve #2 must be drip tight in direction of flow with 1 psi inlet pressure and atmospheric outlet pressure. Check valve #1 must be drip tight against reverse flow with a 1 psi outlet pressure and atmospheric inlet pressure.

Steps:

1. Flush test cocks to remove foreign material.
2. Install sight tube on test cock #3.
3. Open test cock #3 and fill the tube with water to 27 $\frac{3}{4}$ " above centerline of the check valve. Close test cock #3.
4. Close shutoff valve #2.
5. Close shutoff valve #1.
6. Open test cock #3.
7. Open test cock #4. If the water level in the tube remains steady, check valve #2 shall be noted as "tight" or "OK."
8. Open test cock #2. If the water level in the tube remains steady, check valve #1 shall be noted as "tight" or "OK."
9. Close test cocks #2, #3 and #4.
10. Open shutoff valve #1, then shutoff valve #2.

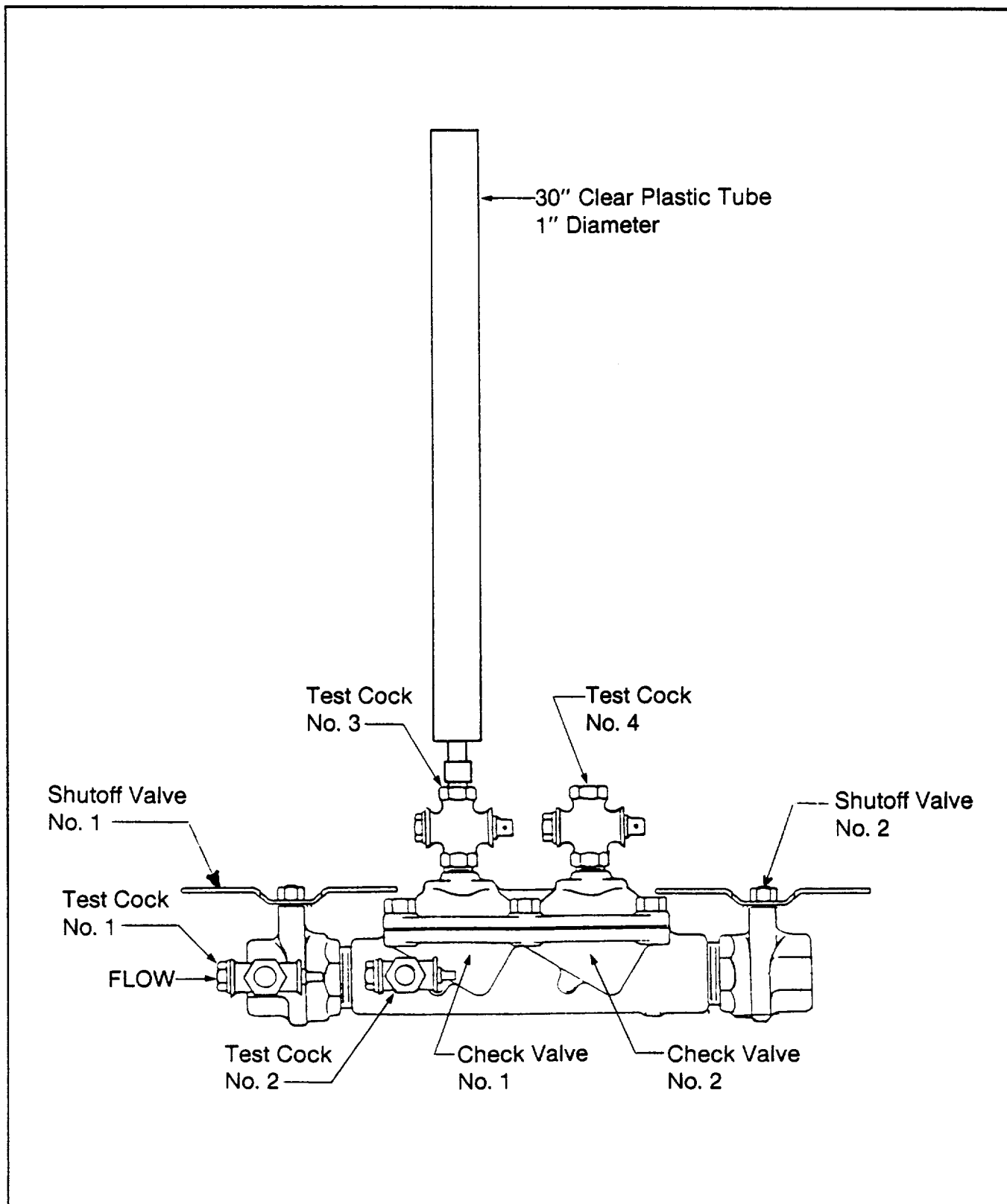


Figure 6-6: Setup For Testing Double Check Valve Assembly Using Sight Tube.

Test Procedure For Double Check Valve Assembly Using Differential Pressure Gauge

Figure 6-7 shows the equipment setup for testing a Double Check Valve Assembly using a differential pressure gauge.

Equipment Required:

- Differential Pressure Gauge - 0 - 15 PSID (0.1 or 0.2 psid graduations)
- Three - 6 ft. lengths - minimum $\frac{1}{4}$ " I.D. high pressure hose with screw type couplings
- $\frac{1}{4}$ " needle valves, for fine control of flows
- Three - $\frac{1}{4}$ " IPS x inverted flare (oxygen fitting, B-size, from welding) -brass or $\frac{1}{4}$ " IPS x 45° SAE flare connector - brass
- Adapter fittings for each test cock size - brass $\frac{1}{8}$ " x $\frac{1}{4}$ ", $\frac{1}{4}$ " x $\frac{1}{2}$ ", $\frac{1}{4}$ " x $\frac{3}{4}$ "

Test #1

Purpose: To test check valve #1 for tightness in the direction of flow.

Requirement: Check valve #1 shall be tight with a 1.0 psi pressure differential in the direction of flow.

Steps:

1. Flush all test cocks to remove foreign material.
2. Connect the high side hose to test cock #2.
3. Connect the low side hose to test cock #3.
4. Open test cocks #2 and #3. Bleed all air from the gauge by first opening the high side, and then the low side bleed valves.
5. Close shutoff valve #2.
6. Close shutoff valve #1.

7. If the differential reading on the gauge is 1.0 psi or greater, then check valve #1 shall be noted as "tight" or "OK."
8. Close test cocks #3 and #2 and remove test equipment.
9. Open shutoff valve #1.

Test #2

Purpose: To test check valve #2 for tightness in the direction of flow.

Requirement: Check valve #2 shall be tight with a 1.0 psi pressure differential in the direction of flow.

Steps:

1. Connect the high side hose to test cock #3.
2. Connect the low side hose to test cock #4.
3. Open test cocks #3 and #4. Bleed all the air from the differential gauge by first opening the high side, and then the low side bleed valves.
4. Close shutoff valve #1.
5. If the gauge reads 1.0 psi or greater, check valve #2 shall be noted as "tight" or "OK."
6. Close test cocks #3 and #4 and remove test equipment.
7. Open shutoff valve #1 then shutoff valve #2.

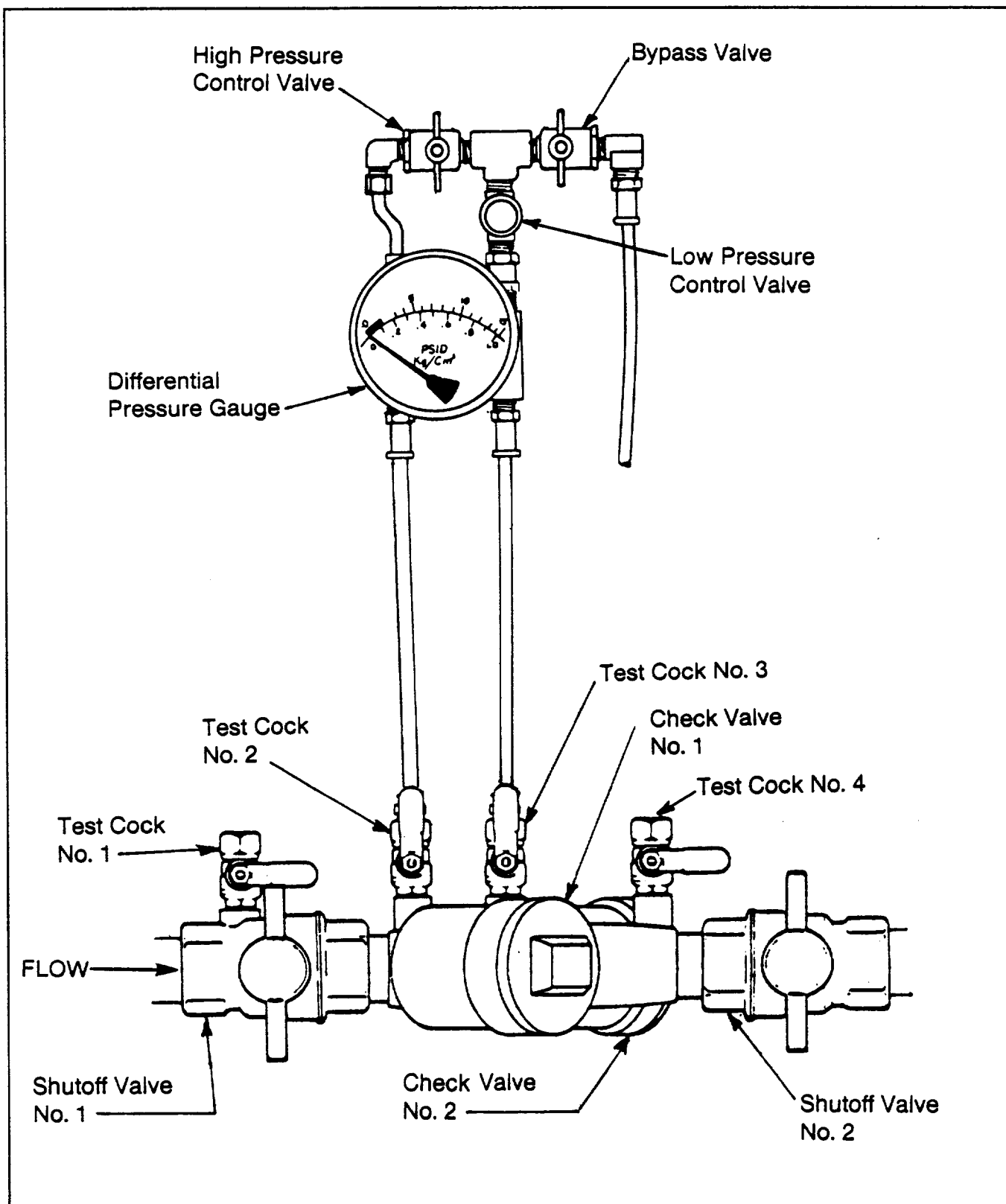


Figure 6-7: Setup For Testing Double Check Valve Assembly Using Differential Pressure Gauge.

Test Procedure For Pressure Vacuum Breaker Using Sight Tube

Figure 6-8 shows the equipment setup for testing a pressure vacuum breaker assembly using a sight tube.

Equipment Required:

- Sight tube (consists of a 1" diameter clear plastic tube about 30" long)
- Appropriate fittings to attach sight tube to the test cocks of the pressure vacuum breaker assembly

Test No. 1

Purpose: To test the opening pressure of the air inlet valve.

Requirement: The air inlet valve shall open when the pressure in the body is no less than 1.0 psi above atmospheric pressure, and the air opening valve shall be fully open when the water drains from the body.

Steps:

1. Flush both test cocks to eliminate foreign material.
2. Remove the air inlet valve canopy.
3. Install sight tube on test cock #2.
4. Close shutoff valve #2.
5. Open test cock #2 and fill tube to 27 $\frac{3}{4}$ " above poppet.
6. Close shutoff valve #1
7. Slowly open test cock #2 while watching poppet. Poppet must unseat. If the air inlet does not open, it is sticking and must be repaired.

Test No. 2

Purpose: To test the check valve for tightness in the direction of flow.

Requirement: The check valve shall be drip tight in the normal direction of flow when the inlet pressure is 1.0 psi and the outlet pressure is atmospheric.

Steps:

1. Install sight tube on test cock #1.
2. Open shutoff valve #1 and allow vacuum breaker to fill with water.
3. Open test cock #1 and fill sight tube to 27 $\frac{3}{4}$ " above check valve.
4. Close shutoff valve #1.
5. Open test cock #1.
6. Open test cock #2. Water may run from test cock initially, but this flow should not continue. The level of water in the sight tube should not drop. If the water level in the sight tube continues to drop, and water continues to run out of test cock #2, the check valve is leaking and must be repaired.
7. Close test cock #1 and test cock #2.
8. Open shutoff valve #1 then shutoff valve #2.

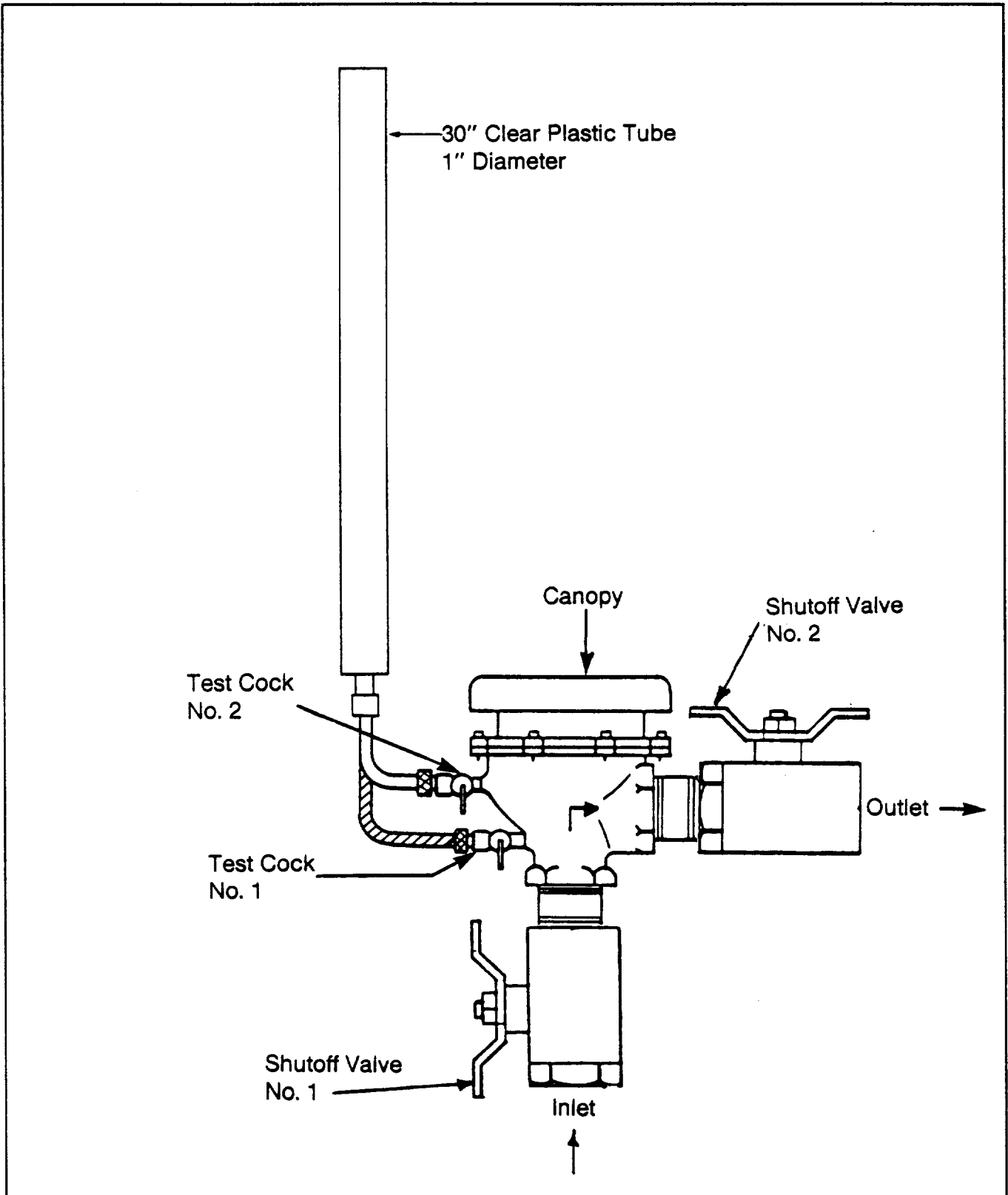


Figure 6-8: Setup For Testing Pressure Vacuum Breaker Assembly Using Sight Tube.

Section 7

Helpful Hints

Cross Connection Control Program Operation

1. Route all new commercial and industrial building permits, plans, and drawings through the person in charge of the cross connection control program.
2. Prior to inspection, gather all available information regarding the premises to be inspected.
3. In the initial stages of the cross connection control program, and on complex inspections, send two inspectors to the customer's premise.
4. The term "water use survey" is preferable to "inspection" since it describes your purpose more accurately. The term "inspection" often causes customers to react defensively.
5. Explain the reasons for cross connection control to each person contacted.
6. Discuss plans for future expansion with the customer.
7. Ask the customer how water is used on the premises.
8. Look for power lines to wells, auxiliary pumps, etc. when making the inspection.
9. Use an inspection report to record results of each inspection (see form in the Appendix). Make diagrams or take pictures of complex or unusual situations.
10. At the time of inspection, explain what type of assemblies will be required and the approximate cost involved.
11. Size the assemblies hydraulically to avoid excessive pressure loss. The head loss is not always directly proportional to flow. Some assemblies may have a large loss at low flow, and low loss at high flow.
12. For installations where service cannot be interrupted, install two or more assemblies which together equal the rated flow of the service line.
13. Furnish the customer with a list of approved assemblies for the type of assembly required (RPBA for high hazard or DCVA for low hazard).
14. Notify the customer in writing to clearly explain where assemblies must be installed, and the completion date of the installation.
15. Establish a file, chart, or computer program to provide reminders for the inspection and annual testing dates of assemblies.
16. Color code and label all piping and outlets when assemblies are installed in hazardous or complex situations.
17. A summary of annual test reports should be maintained to show the number of assemblies tested and failure rates. See forms in Appendix.

Testing Assemblies

1. Visually inspect the test equipment for obvious leaks or damage. Gauges should read zero when not pressurized. Needle valves and fittings must be drip tight.
2. It is recommended that filters be installed on hoses used with test equipment.
3. Notify the owner that the water service will be shut off during the test procedure. If a fire sprinkler service is being shut down, the appropriate people (fire department, alarm monitoring company) must be notified.
4. Verify that the proper assembly is being tested by checking the manufacturer, model, and serial number. Record all information, as well as the test data, before leaving the location.
5. Inspect the assembly for the components required for field test procedures such as #1 and #2 shutoff valves, and #1, #2, #3, and #4 test cocks.
6. Carefully inspect the area around the assembly for tell-tale signs of leakage such as moss, algae growth, plant life, or soil erosion. This gives additional information regarding the assembly's condition before testing is performed. For example, a wet spot under the relief valve indicates possible relief valve activity; perhaps from pressure fluctuations or fouling. Proper testing will define the problem.
7. Use proper field test procedures approved by the local water purveyor or other authority having jurisdiction.
8. Eliminate external leaks at hoses, fittings, packing glands, flanges, or gauge valves before attributing a problem to the shutoff valves.
9. Do not store test equipment in vehicles or areas without heat during the winter. Severe damage from freezing can occur.
10. Test equipment must be checked periodically for accuracy, and calibrated as required.
11. Notify the customer when water service has been restored.
12. A three-part test report form provides a copy for the purveyor, the customer, and the tester.
13. If the relief valve on a reduced pressure backflow assembly requires flushing, this may be done by closing both shutoff valves and opening the #2 test cock. In some cases, this may have to be repeated several times. ***This procedure is considered a repair, and must be noted as such on the test report.***
14. Opening more than one-quarter ($1/4$) turn of the needle valve(s) on the differential gauge dictates when it is necessary to compensate for shutoff valve leaks. An error in the gauge reading may be created when the needle valve(s) is opened more than one-quarter turn.
15. Leaking shutoff valves should be replaced with approved resilient seated valves. However, to compensate for small leaks in the #2 shutoff valve, attach a hose from test cock #1 to test cock #4 and bypass water to compensate for the water leakage. On larger assemblies, a $1/2$ " to $3/4$ " hose may be required.
16. When testing a double check valve assembly, a leaking #1 shutoff valve is indicated if the high side gauge pressure increases and the low side gauge shows no movement. A leaking #2 shutoff valve is indicated if the high side gauge shows no movement, and the low side gauge pressure shows either an increase or decrease, due to increase or decrease in downstream pressure.
17. When testing a double check valve assembly, compression of the check valve disc may cause both gauges to show a pressure fall of 5 to 10 psi before the 2 psi differential is reached.

18. When performing a confirmation test on a double check valve assembly using a duplex gauge, a leaking check valve is indicated when both needles move together equalizing the pressure.
19. When testing a pressure vacuum breaker assembly, the gauge and all hoses must be held at the same elevation as the pressure vacuum breaker assembly being tested. A low side hose filled with water while laying on the ground will cause an error in the gauge reading, even if the gauge head is at the correct elevation. It is suggested that unused hoses be coiled around the gauge head to insure accurate readings.
7. When check valve discs are turned over to implement a repair, this is considered a temporary repair and the disc must be replaced as soon as possible.
8. On RPBA's, RPDAs, and DCDAs, the springs in the #1 check valve are not always interchangeable with the #2 check valve.
9. A spare parts or repair kit is recommended when repairing an assembly.
10. Obtain a good, fast, reliable source of spare parts, and only use original manufacturer's parts. **Use of repair parts other than those furnished by the manufacturer voids approval of the assembly.**

Maintenance And Repair

1. Notify the owner that the water service will be shut off during maintenance of the assembly. If a fire sprinkler service is being shut down, the appropriate people (fire department, alarm monitoring company) must be notified.
2. Verify that the proper assembly is being repaired by checking the manufacturer, model, and serial number. Record all information, as well as the test data, before leaving the location.
3. Consult the manufacturer's maintenance and repair manual for that particular size and model **before** an assembly is disassembled for repairs.
4. Place a drop cloth beneath the assembly when making repairs to catch stray parts.
5. Many problems can be corrected by cleaning the internal components. Carefully observe the condition of parts since some may need to be replaced. In some cases replacement parts must be on hand, such as when a flat or pressed gasket is used.
6. A continuously threaded rod can be used to help relieve the spring pressure on older assemblies where the check valve springs are held by the cap.
11. Lubricants must be used sparingly to assist with the reassembly of components. All lubricants used for this purpose must be USDA approved for potable water.
12. Do not use excessive joint compound or pipe tape on parts when repairing.
13. Bleed off entrapped air after completing repairs.
14. The assembly must be retested and inspected immediately following repair, relocation, or replacement procedures.
15. Notify the customer when water service has been restored.
16. When repairing a backflow prevention assembly, care should be taken to follow good sanitary procedures to keep contaminating materials from entering the assembly and the potable or industrial water system. For assemblies used in premise isolation, (where downstream customers are supplied with potable water), the interior of the assembly and all parts used or reused in making repairs should be disinfected in accordance with American Water Works Association Standard C561-86 by swabbing or spraying with a 1% available chlorine solution.

Troubleshooting Assemblies

Table 7-1: Reduced Pressure Backflow Assemblies

Problem	Possible Cause
Relief Valve discharges continuously.	<ol style="list-style-type: none"> 1. Faulty #1 check. 2. Faulty #2 check with backpressure condition. 3. Faulty Relief Valve.
Relief Valve discharges intermittently.	<ol style="list-style-type: none"> 1. Properly working assembly with backsiphonage condition. 2. #1 check "buffer" is too small (i.e., less than 3.0 psi.) line pressure fluctuation. 3. Water hammer.
Relief Valve discharges after #2 shutoff valve is closed (Test #1).	<ol style="list-style-type: none"> 1. Normally indicates faulty #1 check. <ul style="list-style-type: none"> • Dirty or damaged disc. • Dirty or damaged seat.
Relief Valve would not open, differential on the gauge would not drop (Test #1).	<ol style="list-style-type: none"> 1. Leaky #2 shutoff valve with flow through the assembly.
Relief Valve would not open, differential drops to zero (Test #1).	<ol style="list-style-type: none"> 1. Relief Valve stuck shut due to corrosion or scale. 2. Relief valve sensing line(s) plugged.
Relief Valve opens too high (with sufficiently high #1 check reading).	<ol style="list-style-type: none"> 1. Faulty relief valve. <ul style="list-style-type: none"> • Dirty or damaged disc. • Dirty or damaged seat.
#1 check reading too low (less than 3.0 psi "buffer") (Tests #1 and #3).	<ol style="list-style-type: none"> 1. Dirty or damaged disc. 2. Dirty or damaged seat. 3. Guide members hanging up.
Leaky #2 check (Test #2).	<ol style="list-style-type: none"> 1. Dirty or damaged disc. 2. Dirty or damaged seat. 3. Guide members hanging up.

Table 7-2: Double Check Valve Assemblies

Problem	Possible Cause
Leaky check valve (Test #1 or #2).	<ol style="list-style-type: none"> 1. Dirty or damaged disc. 2. Dirty or damaged seat. 3. Guide members hanging up. 4. Worn hinge pins.

Table 7-3: Pressure Vacuum Breaker Assemblies

Problem	Possible Cause
Air inlet valve does not unseat as gauge drops to 0.0 psid.	<ol style="list-style-type: none">1. Air inlet disc stuck to seat.2. Broken or missing air inlet spring.3. "Old style" pressure vacuum breaker assembly (non loaded air inlet valve).
Air inlet valve does not open, and differential on gauge will not drop.	<ol style="list-style-type: none">1. Leaky #1 shutoff valve.2. Parallel installation with leaky #2 shutoff valve.
Air inlet opens below 1.0 psid.	<ol style="list-style-type: none">1. Dirty or damaged air inlet disc.2. Scale buildup on seat.
Check valve below 1.0 psid.	<ol style="list-style-type: none">1. Dirty or damaged check disc.2. Damaged seat.
Water runs continuously from test cock #2 (Test #2).	<ol style="list-style-type: none">1. Leaky #1 shutoff valve.

Notes: _____

Section 8

Definitions

Air Gap (AG)

The vertical physical separation between the free flowing discharge end of the potable supply line and the overflow rim of the receiving vessel. This separation must be at least twice the inside diameter of the supply line, but never less than one-inch. When located near walls, the air gap separation must be increased.

Approval/Approved

Approved in writing by the health authority or other agency having jurisdiction.

Atmospheric Vacuum Breaker (AVB)

A device which contains a float check (poppet), a check seat and an air inlet vent. When water pressure is reduced to a gauge pressure of zero or below, air enters the device, preventing backsiphonage. It is designed to protect against backsiphonage only.

Auxiliary Water Supply

Any water supply on, or available to, a premise other than the purveyor's approved public potable water supply.

Auxiliary Water Supply - Approved

An auxiliary water supply which has been investigated and approved by the health authority, meets water quality regulations, and is accepted by the water purveyor.

Auxiliary Water Supply - Unapproved

An auxiliary water supply which is not approved by the health authority.

Backflow

The flow of water or other liquids, gases or solids from any source back into the distribution piping of the public potable supply system.

Backflow Prevention Assembly

An assembly which prevents the backflow of water or other liquids, gases or solids into the purveyor's potable water supply and appears on the health authority "Approved" list.

Backflow Prevention Device

A device which prevents the backflow of water or other liquids, gases or solids into the purveyor's potable water supply and does not appear on the health authority "Approved" list.

Backpressure

Water pressure which exceeds the operating pressure of the public potable water supply.

Backsiphonage

Backflow due to a negative or reduced pressure within the public potable water supply.

Barometric Loop (BL)

A loop of pipe rising at least 35 feet at it's uppermost point, above the highest point on the downstream piping.

Certified Backflow Assembly Tester

A person who is certified by the health authority, or other approval agency, to test backflow prevention assemblies.

Certified Cross Connection Control Specialist/Inspector

A person who is certified by the health authority, or other approval agency, to administer a cross connection control program and to conduct cross connection surveys.

Confined Space

Any space having a limited means of egress which is subject to the accumulation of toxic or flammable contaminants or an oxygen deficient atmosphere.

Contamination

An impairment of the quality of the potable water which creates an actual hazard to the public health through poisoning or through the spread of diseases by sewage, industrial fluids or waste. Also defined as high hazard.

Critical Level

The point on a vacuum breaker which determines the minimum elevation above the flood level rim of the fixture or receptacle served at which the vacuum breaker may be installed.

Cross Connection

A point in the plumbing system where the public potable water supply is connected directly, or has the potential of being connected, to a source of non-potable substance that is not a part of the public potable water supply.

Double Check Detector Assembly (DCDA)

An approved assembly consisting of two approved double check valve assemblies, set in parallel, equipped with a meter on the bypass line to detect small amounts of water leakage or use. This unit must be purchased as a complete assembly. The assembly may be allowed on fire line water services in place of an approved double check valve assembly upon approval by the local water authority.

Double Check Valve Assembly (DCVA)

An approved assembly consisting of two independently operating check valves, loaded to the closed position by springs or weights, and installed as a unit with, and between, two resilient seated shutoff valves and having suitable connections for testing.

Flood Level

The highest level to which water, or other liquid, will rise within a tank or fixture (i.e. the overflow rim of the receiving vessel).

Health Authority

The appropriate state or provincial departments or districts of public health or, in some cases, a local agency having jurisdiction.

High Hazard

A physical or toxic hazard which could be detrimental to ones health.

In-plant Protection

The practice of installing backflow prevention assemblies at the point of hazard to protect one or more actual or potential cross connections within a premise.

Internally-loaded Check Valve

A check valve which is internally loaded, either by springs or weights, to the extent it will be drip tight with a 1 psi differential in the direction of flow.

Local Enforcement Authority

Authorized agent of the regulatory authority and/or the water purveyor.

Low Hazard

A hazard which could cause aesthetic problems or have a detrimental effect on the quality of the public potable water supply.

Non-potable Fluid

Any water, other liquid, gas, or other substance which is not safe for human consumption, or is not a part of the public potable water supply as described by the health authority.

Pollution

An impairment of the quality of the public potable water supply which does not create a hazard to the public health but which does adversely affect the aesthetic qualities of such potable waters for domestic use. Also defined as low hazard.

Potable Water

Water which is safe for human consumption, free from harmful or objectionable materials, as described by the health authority.

Premise Isolation

The practice of protecting the public potable water supply by installing backflow prevention assemblies at or near the point where water enters the premise. This type of protection does not provide protection to personnel on the premise.

Pressure Vacuum Breaker Assembly (PVBA)

An approved assembly consisting of a spring loaded check valve loaded to the closed position, an independently operating air inlet valve loaded to the open position and installed as a unit with and between two resilient seated shutoff valves and with suitable connections for testing. It is designed to protect against backsiphonage only.

Private Hydrant

Any hydrant which is not owned, operated or maintained by the local water purveyor or his agent.

Process Water

Water that is directly connected to, or could come in contact with, an extreme high hazard situation, and must never be consumed by humans.

Reduced Pressure Backflow Assembly (RPBA)

An approved assembly consisting of two independently operating check valves, spring loaded to the closed position, separated by a spring loaded differential pressure relief valve loaded to the open position, and installed as a unit with and between two resilient seated shutoff valves and having suitable connections for testing.

Reduced Pressure Detector Assembly (RPDA)

An approved assembly consisting of two approved reduced pressure backflow assemblies, set in parallel, equipped with a meter on the bypass line to detect small amounts of water leakage or use. This unit must be purchased as a complete assembly. The assembly may be allowed on fire line water services in place of an approved reduced pressure backflow assembly upon approval by the local water purveyor.

Used Water

Any potable water which is no longer in the purveyor's distribution system. In most cases, the potable water has moved past (downstream of) the water meter and/or the property line.

Water Purveyor

Any agency, subdivision of the state, municipal corporation, firm, company, mutual or cooperative association, institution, partnership, person or other entity that owns or operates a public potable water system. It also means the authorized agents of such entities as listed above.

Definitions

Notes:

Appendix

The following references were used in the preparation of this manual:

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). Atlanta, Georgia.

AWWA Standard for Disinfecting Water Mains (C651-86). American Water Works Association. Denver, CO.

AWWA Standard for Double Check Valve Backflow Prevention Assembly (C510-89). American Water Works Association. Denver, CO.

AWWA Standard for Reduced Pressure Principal Backflow Prevention Assembly (C-511-89). American Water Works Association. Denver, CO.

AWWA Standard for Resilient Seated Gate Valves for Water and Sewerage Systems (C-509-87). American Water Works Association. Denver, CO.

Clinical Toxicology of Commercial Products. 4th Ed. R. E. Gosselin, Hodge, Smith, and Gleason, editors. Williams and Wilkins Co. Baltimore, MD, 1976.

Communicable Disease Summary. Oregon State Health Division. Volume 38, No. 7, March 28, 1989.

Confined Spaces. National Institute for Occupational Safety and Health. Publication #87-113.

Cross Connection Control Manual. U. S. Environmental Protection Agency, 1975.

Manual of Cross Connection Control. 8th Ed. University of Southern California Foundation for Cross Connection Control and Hydraulic Research, June 1988.

Oregon Administrative Rules, Chapter 33. Public Water Systems, 1990.

Solar Domestic Hot Water Systems and the Water Purveyor. Cross Connection Control Committee, Pacific Northwest Section, American Water Works Association, 1983.

State of Washington Rules and Regulations of the State Board of Health Regarding Public Water Supplies. 1990.

Uniform Plumbing Code. 1988 Ed. IAPMO. Los Angeles, CA.

Working in Confined Spaces. National Institute for Occupational Safety and Health. Publication #80-160.

Sample Ordinance

The purpose of this ordinance, in conjunction with the Uniform Plumbing Code Chapter 10, State of (name of State) cross connection regulations and the current edition of the Cross Connection Control Manual - Accepted Procedure and Practice, published by the Pacific Northwest Section, American Water Works Association, is to protect the health of the water consumer and the potability of the water in the distribution system. Inspection and regulation of all actual or potential cross connections between potable and non-potable systems is required in order to minimize the danger of contamination or pollution of the public potable water supply. Controlling and preventing cross connections is accomplished by either removing the cross connection or installing an approved backflow prevention assembly to protect the public potable water supply.

The (name of water purveyor) is required to eliminate or control all cross connections throughout it's service area. Therefore, anyone wanting or using water from the (name of water purveyor) is required to comply with these regulations. The owner of the property in which a cross connection occurs is fully responsible for all damages incurred.

The (title of responsible official) will enforce the provisions of this ordinance. The (title of official) may delegate responsibilities to a Certified Cross Connection Control Specialist/Inspector. The provisions of this ordinance may supersede State regulations but in no case shall they be less stringent. All approved standards shall be approved by the (name of purveyor) and the (title of responsible official). All backflow prevention assemblies required by this ordinance shall be a model approved by the (name of health authority).

Approved backflow prevention assemblies required by this ordinance shall be installed under the direction of (title of responsible official) and/or under the supervision of the Cross Connection Specialist/Inspector per (name of purveyor) standards.

All RPBA's, RPDAs, DCVAs, DCDAs, and PVBAs are required to be tested at least annually and all Air Gaps installed in lieu of an approved backflow prevention assembly shall be inspected at least annually. Completed Test Reports shall be returned to (name of purveyor) within 30 days after receipt of the yearly test notification. Tests and inspections may be required on a more frequent basis at the discretion of (title of responsible official).

Authorized employees of (name of water purveyor) with proper identification shall have free access at reasonable hours of the day to all parts of a premise or within buildings to which water is supplied. Water service shall be refused or terminated to any premise for failure to allow necessary inspections.

Failure of the customer to cooperate in the installation, maintenance, repair, inspection or testing of backflow prevention assemblies required by this ordinance shall be grounds for termination of water service to the premise or the requirement for an Air Gap separation.

BACKFLOW INCIDENT REPORT FORM

There are many backflow incidents which occur that are not reported. This is usually because they are of short duration and are not detected, the customer is not aware they should be reported, or it may not be known to whom they should be reported.

The PNWS/AWWA Cross Connection Control Committee is making an effort to bring these incidents to the attention of water purveyors and the public. If you have any knowledge regarding backflow incidents, please fill out a copy of this form and return it to any member of the committee, or to the individual named on the reverse side. In addition, the state health agency must be notified.

Reporting Agency: _____ Report Date: _____

Reported By: _____ Title: _____

Mail Address: _____ City: _____

State: _____ Zip Code: _____ Telephone: _____

Date of Incident: _____ Time of Occurrence: _____

General Location (Street, Block, etc.): _____

Backflow Originated From:

Name of Premise: _____

Street Address: _____ City: _____

Contact Person: _____ Telephone: _____

Type of Business: _____

Description of Contaminants:

(Attach chemical analysis or MSDS if available)

Distribution of Contaminant:

Contained within customer's premise: Yes: _____ No: _____

Number of persons affected: _____

Effect of Contamination:

Illness reported: _____

Physical irritation reported: _____

(over)

Cross Connection Source of Contaminant:
(boiler, chemical pump, irrigation system, etc.)

Cause of Backflow:
(main break, fire flow, etc.)

Corrective Action Taken to Restore Water Quality:
(main flushing, disinfection, etc.)

Corrective Action Ordered to Eliminate or Protect Cross Connection:
(type of backflow preventer, location, etc.)

Previous Cross Connection Survey of Premise:

Date: _____ By: _____

Type of Backflow Preventer Isolating Premise:

RPBA: _____ RPDA: _____ DCVA: _____ DCDA: _____ None: _____

Type of Backflow Preventer Isolating Source of Contaminant:

RPBA: _____ RPDA: _____ DCVA: _____ DCDA: _____ PVBA: _____ AVB: _____

Air Gap: _____ None: _____

Date of latest Test of Assembly: _____

Notification of State Health Department:

Date: _____ Time: _____ Person Notified: _____

Notified By: _____

Attach sheets with additional remarks, sketches, and/or media information.

Mail to: Mr. George Bratton
1252 South Farragut Drive
Coupeville, Washington 98239

CROSS CONNECTION CONTROL SURVEY REPORT

DATE _____	FILE NO. _____	TIME _____
------------	----------------	------------

Firm Name: _____ Type Of Business: _____

Address: _____ Zip: _____ Phone No.: _____

Party Contacted: _____ Address: _____

Letter To:

Firm Name: _____ Address: _____

City: _____ State: _____ Zip: _____ Phone No.: _____

City Water Service Size Pressure Meter No.

Domestic _____ _____ _____

Fire _____ _____ _____

Irrigation _____ _____ _____

Other Water Supply _____ _____ _____ Source _____ Use _____

No.	Type Of Cross-Connection And Location	Recommended Remedy

(Sketch)

No.	Type Of Cross-Connection And Location	Recommended Remedy

(Sketch)

Copy to:

- ☐ P. W. Bldg Dept.
☐ Architect
☐ Engineer
☐ Contractor
☐ Fire Prevention Bureau

WATER SYSTEM PLAN CHECK

PROJECT _____

PROJECT LOCATION _____

NAME	Plans Submitted By	DATE
------	--------------------	------

ADDRESS	Street	City	Zip
---------	--------	------	-----

PHONE _____

WATER DISTRIBUTION SECTION

Requirements: _____

	DISTRIBUTION ENGINEER
--	-----------------------

WATER QUALITY SECTION

Requirements: _____

	WATER QUALITY ENGINEER
--	------------------------

Line Pressure at Time of Test: _____ LBS. Type of Assembly: _____

(A-7)

NO. 000000

BACKFLOW PREVENTION ASSEMBLY TEST REPORT
☐ New
☐ Replacement

Firm Name: _____

Device Address: _____
Street

City

Zip

Device Size: • Device Make: Model: Water System: _____ Serial Number:

Device Location: _____

INITIAL TEST	REDUCED PRESSURE ASSEMBLY			PRESSURE VACUUM		INITIAL TEST
	DOUBLE CHECK VALVE		Check #1	BREAKER		
	Check #1	Check #2		Air Inlet	Check	
	Tight <input type="checkbox"/> Leaked <input type="checkbox"/> Press Drop <input type="text"/> <input type="text"/> • <input type="text"/> psid	Tight <input type="checkbox"/> Leaked <input type="checkbox"/> Press Drop <input type="text"/> <input type="text"/> • <input type="text"/> psid		Relief Opened At <input type="text"/> <input type="text"/> • <input type="text"/> psid Relief Valve Passed <input type="checkbox"/> Failed <input type="checkbox"/>	Opened At <input type="text"/> <input type="text"/> • <input type="text"/> psid Did Not <input type="checkbox"/> Open	
REPAIRS AND/OR PARTS						
TEST AFTER REPAIR	Tight <input type="checkbox"/>	Tight <input type="checkbox"/>	#1 Press Drop <input type="text"/> <input type="text"/> • <input type="text"/> psid Relief Open <input type="text"/> <input type="text"/> • <input type="text"/> psid	Opened At <input type="text"/> <input type="text"/> • <input type="text"/> psid	Press Drop <input type="text"/> <input type="text"/> • <input type="text"/> psid	After Repair Date: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

Detector Meter Reading: _____

IN COMPLETING AND SUBMITTING THIS TEST REPORT, THE TESTER CERTIFIES THAT THE DEVICE HAS BEEN TESTED AND MAINTAINED IN ACCORDANCE WITH ALL APPLICABLE RULES AND REGULATIONS OF THE WATER SYSTEM OWNER AND THE STATE.

*Tester's Signature*_____
*Gauge #*_____
Cert. #

Report Received By: _____ (Representative or Firm)

White - Water System

Pink - Customer

Yellow - Tester

FIRM NAME		FILE NO.	ASSEMBLY NO.
ADDRESS		ZIP	PHONE NO.
PARTY CONTACTED		TITLE	
TYPE OF ASSEMBLY			
<input type="checkbox"/> Reduced Pressure Backflow Assembly <input type="checkbox"/> Double Check Valve Assembly <input type="checkbox"/> Pressure Vacuum Breaker Assembly			
MAKE OF ASSEMBLY	MODEL	SERIAL NO.	SIZE
DATE INSTALLED		METER NO.	
CROSS-CONNECTION CONTROLLED			
LOCATION OF ASSEMBLY			

[illegible]

TEST EQUIPMENT CALIBRATION FORM

Name: _____

Address: _____

Street

City

Zip

Duplex

Diff. Press.

Gauge I.D. #: Type:

Make: _____

Model #:

Calibration Adjustment Required

Duplex: Green
(Low Needle): Low ☐ High ☐ None ☐Red
(High Needle): Low ☐ High ☐ None ☐Differential Pressure: Low ☐ High ☐ None ☐Repairs And/
Or Parts

Comments:

Yes

No

All necessary adjustments have been made:

☐☐This gauge has been calibrated in compliance with _____
Administrative Rules.

Date Of Calibration:

Next Calibration Date:

Calibrator's Name: _____

Calibrator's #:

CONFINED SPACE ENTRY PERMIT

PRE-ENTRY	Location of work: _____					
	Good on this day only: _____ From: _____ a.m./p.m. To: _____ a.m./p.m.					
	Description of work planned: _____ _____					
	Workers authorized entry: _____ _____					
No one shall enter any confined space under any condition until it has been properly tested for O ₂ deficiency and toxic/flammable gases. Appropriate procedures <i>MUST BE</i> followed.						
ALL QUESTIONS MUST BE ANSWERED	YES	NO				
	<input type="checkbox"/>	<input type="checkbox"/>	Has atmospheric test been conducted to determine oxygen deficiency or excess, flammability, toxicity?			
	<input type="checkbox"/>	<input type="checkbox"/>	Is fire extinguisher immediately available?			
	<input type="checkbox"/>	<input type="checkbox"/>	Are any mechanical, electrical, corrosive, or temperature hazards possibly present?			
	<input type="checkbox"/>	<input type="checkbox"/>	Has the space been ventilated?			
	<input type="checkbox"/>	<input type="checkbox"/>	Is safety harness with life lines attached needed?			
	<input type="checkbox"/>	<input type="checkbox"/>	Does the work require staging or ladder?			
	<input type="checkbox"/>	<input type="checkbox"/>	Have the employees been thoroughly briefed on the potential hazards and the safe and efficient methods of completing the particular job?			
PROTECTIVE EQUIPMENT	CHECK ITEMS REQUIRED					
	<input type="checkbox"/> Hard Hat	<input type="checkbox"/> Safety Harness-Lifeline	<input type="checkbox"/> Gloves			
	<input type="checkbox"/> Fire Extinguisher	<input type="checkbox"/> Breathing Apparatus	<input type="checkbox"/> Goggles			
	<input type="checkbox"/> Hearing Protection	<input type="checkbox"/> Rubber Boots	<input type="checkbox"/> Testers			
	<input type="checkbox"/> Other (specify): _____					
ATMOSPHERIC TEST RESULTS	DATE	TIME	TECH. INITIAL	O₂%	COMB. GAS % LEVEL	TOXICITY PPM
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
Model and serial number of test instruments: _____ _____						
Date last calibrated: _____						
NOTE	RETESTING REQUIRED IF: 1. CONDITIONS CHANGE; 2. START OF WORK IS DELAYED OR STOPPED MORE THAN 30 MINUTES.					
	HOT WORK PERMIT IS ALSO REQUIRED WHEN DOING WELDING/BURNING IN CONFINED SPACE.					
Signature of Foreman/Supervisor in charge of this work: _____ _____						
Copy Distribution: Foreman/Supervisor in charge of this work Safety						

American Water Works Association
Pacific Northwest Section
Cross Connection Control Committee

Summary Of Annual Test Reports - Year: _____

Reduced Pressure Backflow Assemblies

Make & Model Of Assembly: _____

SIZE OF ASSEMBLY (Inches)	TOTAL NUMBER OF TESTS	NUMBER OF FAILURES						
		(a) No. 1 Check	(b) No. 2 Check	(c) Both Checks	(d) Relief Valve	(e) Relief & Either Check	(f) Relief & Both Checks	(g) No. 1 CV - Relief < 3 PSI
0.375								
0.50								
0.75								
1.00								
1.25								
1.50								
2.00								
2.50								
3.00								
4.00								
6.00								
8.00								
10.00								

Name Of Water Utility: _____

Report By: _____ Telephone No.: _____

American Water Works Association
 Pacific Northwest Section
 Cross Connection Control Committee

Summary Of Annual Test Reports - Year: _____

Double Check Valve Assemblies

Make & Model Of Assembly: _____

SIZE OF ASSEMBLY (Inches)	TOTAL NUMBER OF TESTS	NUMBER OF FAILURES		
		(a) No. 1 Check	(b) No. 2 Check	(c) Both Checks
0.375				
0.50				
0.75				
1.00				
1.25				
1.50				
2.00				
2.50				
3.00				
4.00				
6.00				
8.00				
10.00				

Name Of Water Utility: _____

Report By: _____ Telephone No.: _____

American Water Works Association
Pacific Northwest Section
Cross Connection Control Committee

Summary Of Annual Test Reports - Year: _____

Pressure Vacuum Breaker Assemblies

Make & Model Of Assembly: _____

SIZE OF ASSEMBLY (Inches)	TOTAL NUMBER OF TESTS	NUMBER OF FAILURES		
		(a) Air Inlet	(b) Check Valve	(c) Both CV & Inlet
0.50				
0.75				
1.00				
1.25				
1.50				
2.00				

Name Of Water Utility: _____

Report By: _____ Telephone No.: _____

ORDER FORM

CROSS CONNECTION MATERIALS from PNWS - AWWA

I would like a copy of the following Cross Connection Control materials. Please send this order form to: Judy Grycko, PNWS-AWWA Sec/Treas, PO Box 19581, Portland, Ore. 97280 [(503) 246-5845] or [(503) 246-6034 fax].

<u>HOW MANY</u>	<u>COST</u>	<u>ITEM</u>
_____	\$ _____	A. Summary of Backflow Incidents. Case histories of actual cross connections and their hazards. \$(<u>15.00</u> ea) for individual copies, \$(<u>5.00</u>) for updates
_____	\$ _____	B. Computerized Database Backflow Program. Keep track of your backflow prevention assemblies, testers and notices to customers required to have their preventers tested. (This program requires "Fox Pro, D Base 3+ or D Base 4" to run). \$(<u>100.00</u> ea) for individual copies
_____	\$ _____	C. Demo disk for the Database Backflow Program. This will give you an up close example of all the functions this program has. \$(<u>10.00</u> ea)
_____	\$ _____	D. Fifth Edition of the PNWS - AWWA Cross Connection Control Committee's Accepted Procedure and Practice in Cross Connection Control Manual (Yellow Manual). Current guide lines and procedures in managing an effective cross connection control program. \$ (<u>25.00</u> ea) for individual copies or \$ (<u>20.00</u> ea) for boxes of 50
_____	\$ _____	E. Irrigation Brochure**
_____	\$ _____	F. Firesprinkler Brochure**
_____	\$ _____	G. Cross Connection Brochure**
_____	\$ _____	Total Amount

** All Brochures are sold in quantity lots as follows:

200 = \$40.00 500 = \$90.00 1000 = \$150.00

First Five Brochures Free Upon Request

YOUR NAME _____ PHONE NUMBER _____ - -
COMPANY NAME _____
STREET ADDRESS _____
MAILING ADDRESS _____
CITY _____ STATE _____ ZIP _____
PURCHASE ORDER NUMBER _____

SIGNED _____ DATE _____

August 13, 1991

Other Publications Available From The Pacific Northwest Section American Water Works Association:

Summary Of Backflow Incidents

A 3-ring binder containing reports of backflow incidents. Updated reports are provided periodically to holders of this binder. It is a very useful educational tool.

Home Irrigation Safety

A 3 1/2 X 8 1/2, 4-fold pamphlet illustrating backflow protection for home irrigation systems. The pamphlet illustrates installation standards and describes the AVB, PVBA, DCVA, and RPBA. Up to 5 copies are available with no charge.

Cross Connection Control For Residential Fire Sprinkler Systems

A 3 1/2 X 8 1/2, 4-fold pamphlet illustrating the difference between direct and indirect systems, and their backflow protection requirements. Up to 5 copies are available with no charge.

Cross Connections Can Create Health Hazards

A 3 1/2 X 8 1/2, tri-fold pamphlet explaining in simple terms what constitutes a cross connection, and danger associated with cross connections. Up to 5 copies are available with no charge.

Computer Database Program

Backflow Prevention Assemblies computer data base software which will allow water purveyors to manage a cross connection program to insure that all backflow prevention assemblies are tested annually while developing statistics on problems encountered by particular makes, models, or sizes of assemblies.

Demo Disk For Database Backflow Program

This disk will give you an up-close example of all the functions this program has. Cost is \$10.00.

These publications may be ordered from:

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PNWS-AWWA/SEC-TREAS
PO Box 19581
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(503) 246-5845
Fax (503) 246-6034

Notes:

